THE SPECIES OF *ARDEICOLA* (PHTHIRAPTERA: ISCHNOCERA) PARASITIC ON THE CICONIIDAE

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CONTENTS

SYNOPSIS

Sixteen species of *Ardeicola* from the Ciconiidae have been described, certain homologous characters of all compared and a key for their identification provided. The four new species are *A. dissourae* from *Dissoura episcopus microscelis*, *A. senegalensis* from *Ephippiorhynchus senegalensis*, *A. asiaticus* from *Xenorhynchus a. asiaticus* and *A. keleri* from *Ibis ibis*.

INTRODUCTION

The genus *Ardeicola* Clay, 1935 includes Ischnocera which live on the back and wings of Ciconiiformes, have an elongated and depressed body (Clay, 1957*b*), and can be diagnosed by the following combination of characters, especially those of the head.

Head. Marginal carina interrupted medially and laterally into pre- and postmarginal carinae. Hyaline margin arises at distal ends of premarginal carinae. Dorsal preantennal suture usually directed posteriorly, sometimes transversely also; a dorsal anterior, and a smaller ventral plate with usually numerous discrete, exceptionally few indistinct, thickenings. Ventral carina interrupted medially and passing anteriorly to fuse with distal end of premarginal carina; pulvinus with lobes attached to flattened, thickened, parallel edges of ventral carinae. Temporal carinae usually absent. Coni better developed in female than in male. Gular plate distinct. Hypopharynx well developed. Usually much sexual dimorphism in antennae. Head setae typical for Ischnocera (see Clay, 1951).

Thorax and abdomen. Pro- and pteronotum either undivided or divided medially. On both 1+1 anterior m, sp, or sh setae. (For explanations to abbreviations see page 158). On prothorax usually 2+2 posterior setae; outer sp or sh, inner sh to lg; rarely only 1+1 (inner) setae. On pteronotum either 5+5, 6+6 or 7+7 posterior setae; of these 1+1 are always trichobothrium-like (here called thoracic trichobothria), and 1+1 are sp and their position relative to each other diagnostic. Abdomen with 8 apparent segments, interpreted thus; apparent 1 as II (actually I + II fused), 2 to 7 as III to VIII; in the male 8 either as IX–XI or its greater anterior portion as IX + X and the posterior smaller portion as XI; in the female 8 always as IX–XI. In the male tergal thickening VI–VIII usually as transverse plates continuous across the segment; of other segments variable. In the female tergal thickening II–VIII as lateral tergites; of IX–XI as a large plate continuous across segment, but falling short of lateral segmental margins. Male genital opening ventral. Setae always present are: 1+1 postero-lateral trichobothria on tergum VIII, here referred to as abdominal trichobothria; anal, 3+3 (Clay, 1951); 2+2 in genital region, referred to as *d*; and in female 1+1 on sternum VIII.

The following characters described fully in the next section are common to species of *Ardeicola* from the Ciconiidae. They clearly indicate a division within the genus above the specific level, here designated as the *ciconiae* group.

1. Position of anterior dorsal setae (Text-fig. 6). 2. Nature of pro- and pteronotum (Text-figs 2, 16). 3. Number, 7+7, and arrangement of postero-lateral pteronotal setae (Text-fig. 18) (especially of telg setae). 4. Number, 1+1, of anterior tc setae on segment II, and 1+1 anterior and 2+2 posterior tergal setae on segment IX-XI (Text-figs 36, 37). 5. The distribution of post-spiracular setae (Text-fig. 17 and fig. 6 in Tandan & Kumar, 1969). 6. Absence of pleural setae on II and their number, 1+1, on III (Text-fig. 16).

REVIEW OF SOME HOMOLOGOUS CHARACTERS IN THE *CICONIAE* GROUP

The sixteen species herein described vary strikingly in the degree of sclerotization thus: poor, *leucosoma;* feeble to moderate, *keleri, asiaticus, tantali, maculatus,* and *loculator* female; heavy (or well sclerotized), the remaining species. The colour pattern is important for separating the otherwise morphologically similar females of *tantali* and the three closely related species (nos 7, 9, 10); it is also important for diagnosing the female of *loculator.* The degree of dimorphism in the length of the two sexes also differs notably (Text-fig. 1).

HEAD AND THORAX. The head varies in shape, but morphologically it is remarkably uniform. The hyaline margin is broad and prominent. The preantennal region is usually slightly longer than the postantennal, the difference being less in the male than in the female. In the male of *lepidus* the preantennal region is slightly shorter than, and in the female longer than or equal to, the postantennal region. In *hopkinsi* the preantennal region is appreciably longer.

The following features of the preantennal region are uniform for the group (Text-figs 2, 4, 6): Length of premarginal carinae; shape of dorsal anterior plate and its modified central area; shape of ventral plate, especially its emarginate posterior margin, and the numerous thickenings on it. Position of dorsal submarginal seta, behind tip of premarginal carina; of anterior dorsal seta, posterior relative to anterior ventral setae 1 and 2, rarely at about the same level as avs 2; of ventral submarginal seta 1 slightly anterior or posterior to ventral submarginal seta 2; of anterior seta 1 slightly anterior or posterior to avs 3. In the male antennal segments II-V, and in the female III-V, are together longer than segments I and II respectively.

Of the eleven well sclerotized species, the dorsal carinae extend to the midline in *loculator* (fig. 10 in Kumar & Tandan, 1968), otherwise these endocarinae are less evident medially (Text-figs 2, 3). The posterior margin of the dorsal anterior plate is usually greatly curved, but in *signatus* and *lepidus* it is much less so, being almost straight (Text-figs 4, 5). Temporal carinae are present only in *loculator* and *ciconiae* males, being well developed in the former, weakly so in the latter species. The gular plate is usually more heavily pigmented than the dorsal cuticle, above or around it. The difference is more marked in *bicolor, dissourae, senegalensis,* and *castaneus,* but it is perceptible in all others, excepting *leucosoma* and *loculator.* In *leucosoma* and *loculator* female there is no difference,while in *loculator* male the plate

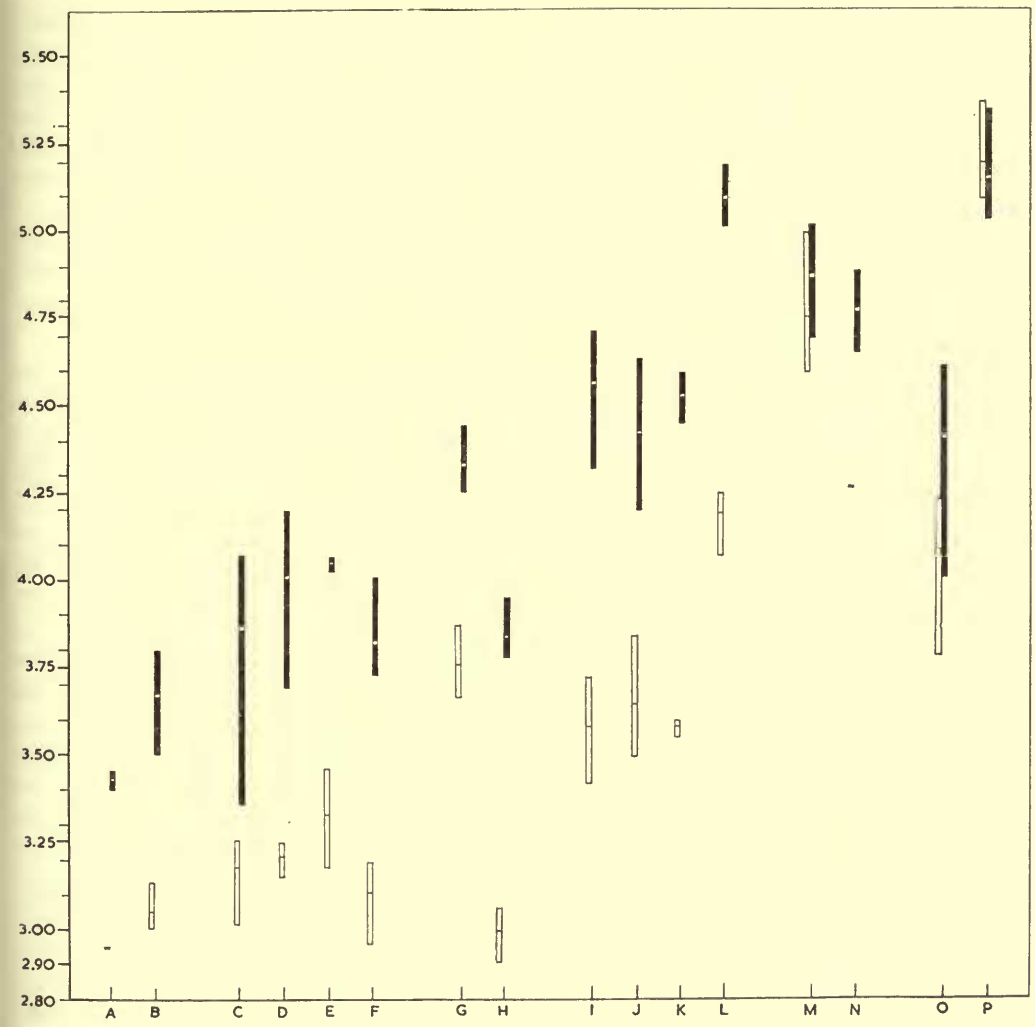


FIG. 1. Dimorphism in length (in millimetres) of males (left-hand side column in white) and females (right-hand side column in black) of *Ardeicola* species of *ciconiae* group. Line across each column represents the average length: (A) *A. signatus*; (B) *A. lepidus*; (C) *A. bicolor*; (D) *A. dissourae* sp. n.; (E) *A. senegalensis* sp. n.; (F) *A. castaneus*; (G) *A. loculator*; (H) *A. leucosoma*; (I) *A. keleri* sp. n.; (J) *A. tantali*; (K) *A. asiaticus* sp. n.; (L) *A. maculatus*; (M) *A. ciconiae*; (N) *A. hopkinsi*; (O) *A. hardayali*; (P) *A. fissomaculatus*.

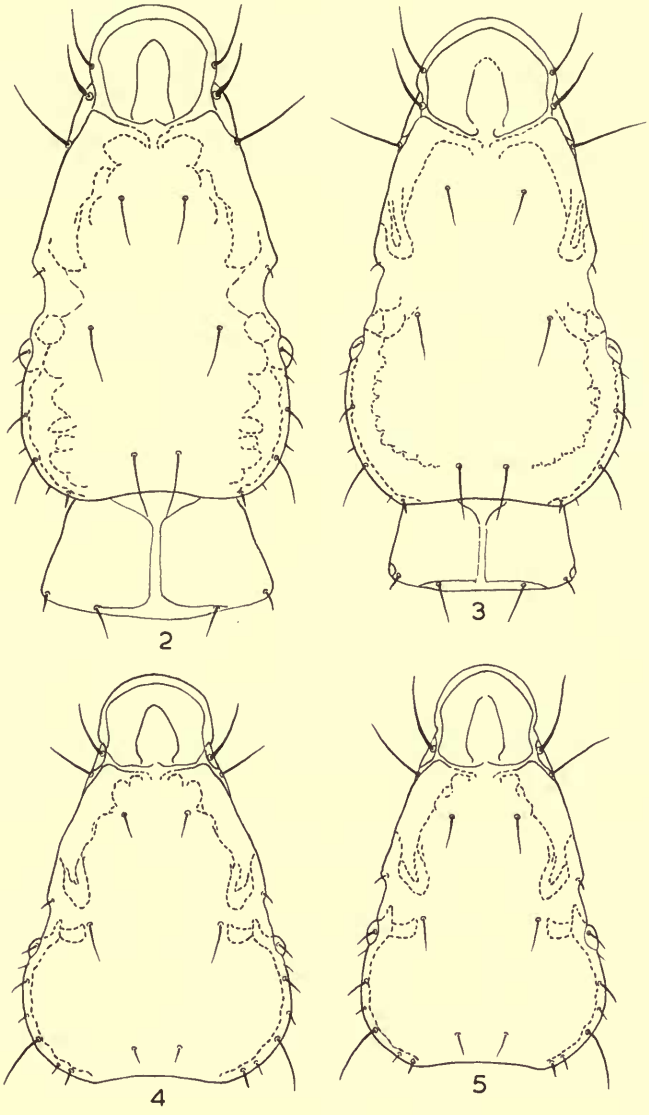
is markedly less sclerotized. Its pigmentation is almost uniform or noticeably darker anteriorly. Occipital carinae are usually poorly sclerotized, but are well so in *bicolor* and *fissomaculatus* (perhaps in *dissourae* and *hardayali* also).

Coni are poorly developed and hidden in males of eight species, nos 1–6, 11, 12, and just projecting beyond margins of the head in *tantali* and related species (nos 7, 9, 10), *ciconiae*, *hopkinsi*, *fissomaculatus* and *hardayali*. In females they are moder-

ately developed and fall slightly short of or reach to the middle of first antennal segment in *bicolor* and the three related species (nos 3, 5, 6) and in *leucosoma*, *fissomaculatus* and *hardayali*. In nine species they reach beyond the middle of first antennal segment. The outer rounded margin in the male and pointed apex in the female is distinctly thickened in *fissomaculatus;* in other species of identical habitus this character is not determinable as the series are suboptimal. The approximate ratio of antennal segments II-V: I in the male is in *fissomaculatus*, 1·09; *ciconiae*, 1·17; *castaneus*, *leucosoma* and *hopkinsi*, 1·34–1·38; *senegalensis*, *dissourae*, *hardayali*, *maculatus*, *tantali*, *lepidus* (Text-fig. 7) and *asiaticus*, 1·40–1·49; *signatus*, *keleri*, and *bicolor*, 1·50–1·59; *loculator*, 1·60. In the female (Text-fig. 12) the ratio of segments III-V: II is from 1·82–2·27.

The anterior dorsal seta (ml to lg) is well removed from the preantennal suture and is slightly posterior relative to anterior ventral setae 1 and 2; rarely the adsmay be at the same level as avs 2 (Text-fig. 6). Minute second ad setae may also be present in males of *tantali* and related species, nos 7, 9, 10. Dorsal submarginal (lg) is basally stout and subapically on premarginal carina. Postnodal seta is usually ml or ml to lg, but sh to ml in *bicolor* female. Post-temporal seta in the female is sh and falls much short of the occiput. But in the male it shows great variation in length relative to the occiput, as follows : 1. Falls short of it in *loculator* (usually sh or ml also), *leucosoma*, *hardayali*, *fissomaculatus* (sh to ml), and *hopkinsi* (ml). 2. Reaches it in *signatus* (ml), *lepidus* (ml to almost lg), *senegalensis* (almost lg), *bicolor* (lg). 3. Crosses it slightly in *signatus*, and *lepidus*. 4. Crosses it well in *dissourae* (lg), *castaneus*, *bicolor*, *tantali* and related species (lg). A. *ciconiae* (ml to lg) is the only species in which it may either fall short of the occiput or cross it slightly. Preantennal seta is sp or sh. Preconal is mostly sh to ml in the male and ml to lg in female; also sh in *signatus* male, ml in *dissourae* male, ml to lg in *ciconiae* and almost lg in *maculatus*. Ocular seta is usually sh but sometimes ml; in *ciconiae* male it is ml to almost lg. The alveolus is on the cornea, but close to temporal margin. Of the 6 marginal temporal setae, 1 is always sp or sh and fine, but m in *bicolor;* 2 is usually sh, but is sh to ml in *maculatus* and *ciconiae*, and ml in *fissomaculatus*. In the same species marginal temporal 2 and ocular resemble each other in proportions. Marginal temporals 3 and 5 are much like 1 in proportions; 6 is sp, stouter than 1, 3 and 5. Marginal temporal 4 is usually ml, but sh to ml in *keleri* male, ml to almost lg in *signatus* male, *ciconiae*, *leucosoma* female, *loculator*, *tantali*, and *maculatus* and lg in *leucosoma* male. Mandibular seta is usually ml to lg; also sh in *lepidus* male, sh to ml in *hopkinsi*, *hardayali*, *fissomaculatus*, ml in *castnaeus*, *leucosoma* and *loculator* male. The remaining head setae are ml to lg; their lengths are not important.

The thorax shows no striking differences. The pronotum is apparently divided medially; there are 2+2 posterior prothoracic setae in all species except *loculator* which has 1+1 setae only, as the 1+1 (rarely 3 also) outer setae are absent. The outer setae may be slightly thinner in the female than in the male. The pteronotum is medially divided in about its posterior half; a definite medial suture traverses its anterior half also, along which a split often occurs during preparation. On the pteronotum there are normally 7+7 characteristically arranged postero-lateral

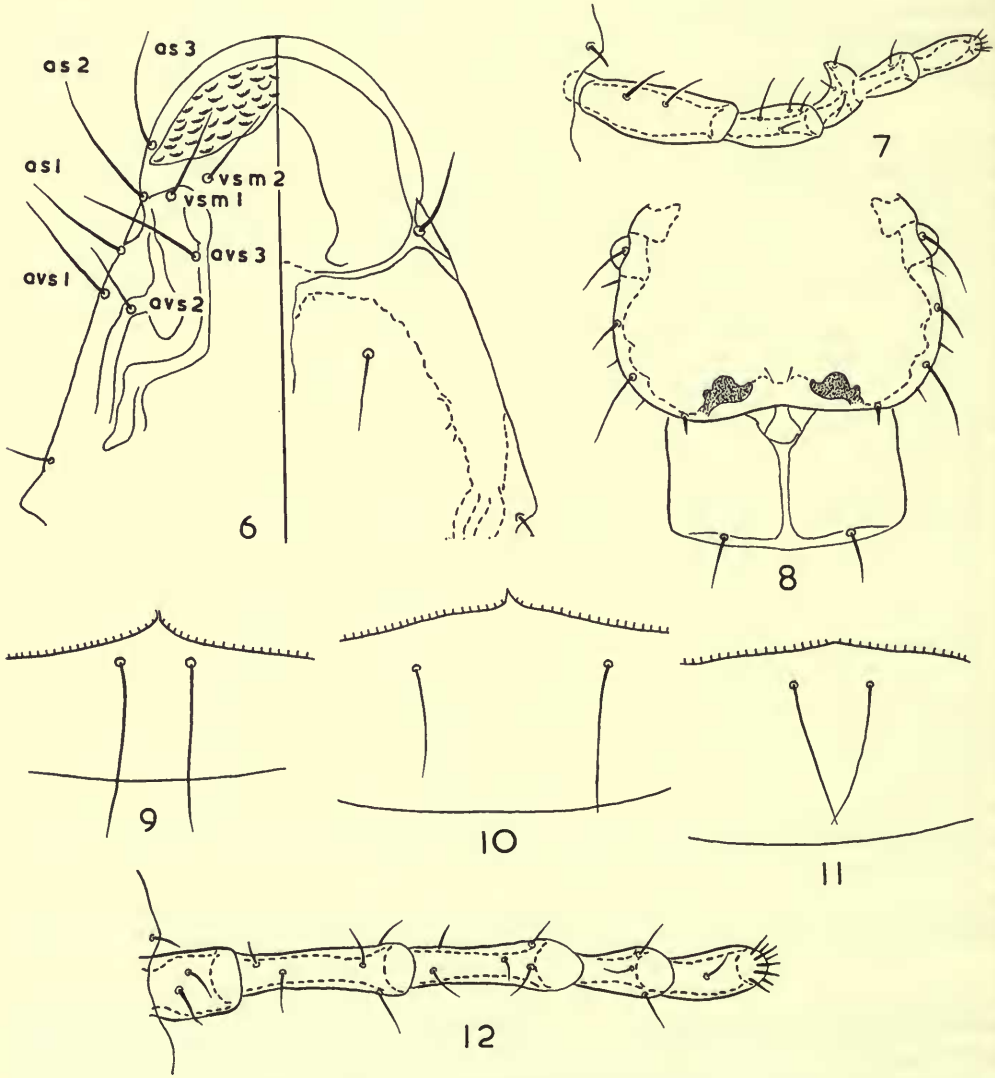


FIGS 2–5. Heads of *Ardeicola*: 2, *A. dissourae* sp. n. male; 3, *A. bicolor*, male; 4, *A. lepidus*, female; 5, *A. signatus*, female.

setae (Text-fig. 16); of these 5+5 are lg to elg and have contiguous alveoli which lie in one unsclerotized area; posterior to these are the 1+1 pterothoracic trichobothria, outer relative to the 1+1 thoracic sp setae (Text-figs 16, 30). Meso- and metasternal setae vary in number.

ABDOMEN. The shape and proportions of the segments are fairly constant in both sexes and this uniformity of the female abdomen is important.

Tergal thickening. In the male tergal thickening of segments II-IV is usually in the form of distinct lateral tergites. Those of II are narrowly separated medially, but diverge characteristically at the level of the 2 anterior tc setae; those of III and IV are medially wide apart. In *loculator* and *leucosoma* central sclerotization, less intense than the lateral tergites, makes the latter of II-IV continuous across the terga. Inner contours of III are not well defined in *lepidus* (Text-fig. 13). Thick-



FIGS 6–12. 6, 7, *A. lepidus*, male, preantennal region of head and antenna; as, anterior seta; avs, anterior ventral seta; vsm, ventral submarginal seta; 8, *A. loculator*, female, postantennal region of head and prothorax; 9–11, Tergocentral setae on segment VIII: 9, *A. dissourae* sp. n.; 10, *A. castaneus*; 11, *A. bicolor*; 12. *A. maculatus*, female, antenna.

ening of III and IV is apparently transversely continuous in *signatus;* in *senegalensis* II and III are less sclerotized centrally and in which no well defined contours of lateral tergites are evident, and the thickening is apparently continuous across (Text-fig. 15). Thickening of V is as distinct lateral tergites in *keleri*, and seems to be so in the three related species also (nos 7–9). In others it is continuous across the segment; and always so in VI-VIII. On some terga, V and VII in *hopkinsi*, V-VIII in *ciconiae, loculator, hardayali*, and only VIII in *fissomaculatus*, contours of lateral tergites are evident. This indicates that in these, and perhaps in other species too, the tergal thickening is primarily as lateral tergites which become continuous across as a result of sclerotization of the central tergum. The anterior margin of tergite V shows much variation and its nature is important. It is either straight in *lepidus* (Text-fig. 13), or slightly emarginate in *ciconiae* to deeply emarginate in *bicolor* and related species (nos 3, 5, 6) (Text-figs 14, 15, 18, 19) and in *loculator* and *hardayali*. Anterior margin of tergal thickening VI-VIII may be straight, medially depressed or emarginate. Maximum curvature in the posterior margin of tergites VI and VII is seen in *loculator* and *hopkinsi* (figs 1, 11 in Kumar & Tandan, 1968). Composite tergum IX-XI is sclerotized all over except for narrow strips antero-laterally (*hardayali, fissomaculatus*), or a strip posteriorly (*fissomaculatus*) (figs 2, 3 in Tandan & Kumar, 1969). The anterior margin of tergite IX-XI is usually more or less straight, but is curved slightly in *hopkinsi* (fig. 5 in Kumar & Tandan, 1968) and *castaneus*, more in *hardayali* (fig. 2 in Tandan & Kumar, 1969), considerably in *ciconiae* or it is noticeably raised medially in *loculator* and *senegalensis* (Text-fig. 33) or depressed medially in *lepidus* and *fissomaculatus* (fig. 3 in Tandan & Kumar, 1969).

In the female, tergal thickening of segments II-VII is as lateral tergites, different in shape from those of the male; those of III in *lepidus* (Text-fig. 16) may, and of II in *senegalensis*, have indistinct contours. The tergum between and posterior to the lateral tergites is either unhardened or relatively less intensely hardened.

In some females (*a* type) of *bicolor* the tergum between lateral tergites IV-VIII and posterior to III-VIII is pigmented, but in others not (*b* type). In yet others (*c* type) the extent of central and posterior pigmentation differs, and such females can be arranged in a series which has at one end individuals more extensively pigmented in these portions and at the other those much less so. The former are closer to the *a* type, the latter to the *b* type of females described above.

In other species there is considerable variation in the extent of these areas of pigmentation. Apparently these are absent in *signatus*, and only the posterior one is present in *lepidus*. In *ciconiae* the central pigmentation is evident along the inner margins of lateral tergites III-VII or VIII; the posterior on II-VIII, showing progressive decrease posteriorly. *A. hardayali* is like *ciconiae*, but may lack completely the central pigmentation, and the posterior one is less intense. *A. fissomaculatus* has central pigmentation of tergum II only, the posterior one being as in *hardayali*.

The anterior margin of tergite IX-XI is (apparently) almost straight in *signatus;* it is medially slightly depressed in *lepidus, bicolor, hopkinsi, leucosoma*, or medially slightly emarginate *hardayali* and *fissomaculatus*. Its lateral margins are usually curved, being considerably so in *hardayali* and *fissomaculatus*.

Sternal thickening. In both sexes sternal thickening of segments III-VIII is in the form of lateral plates, which increase in size progressively posteriorly; that of II is usually not apparent, rarely so as faint, narrow, lateral plates. Lateral sternites VIII continue posteriorly and either merge to form the subgenital plate or remain as lateral plates. In the male the terminal sternum which forms the margin of the genital opening is never thickened.

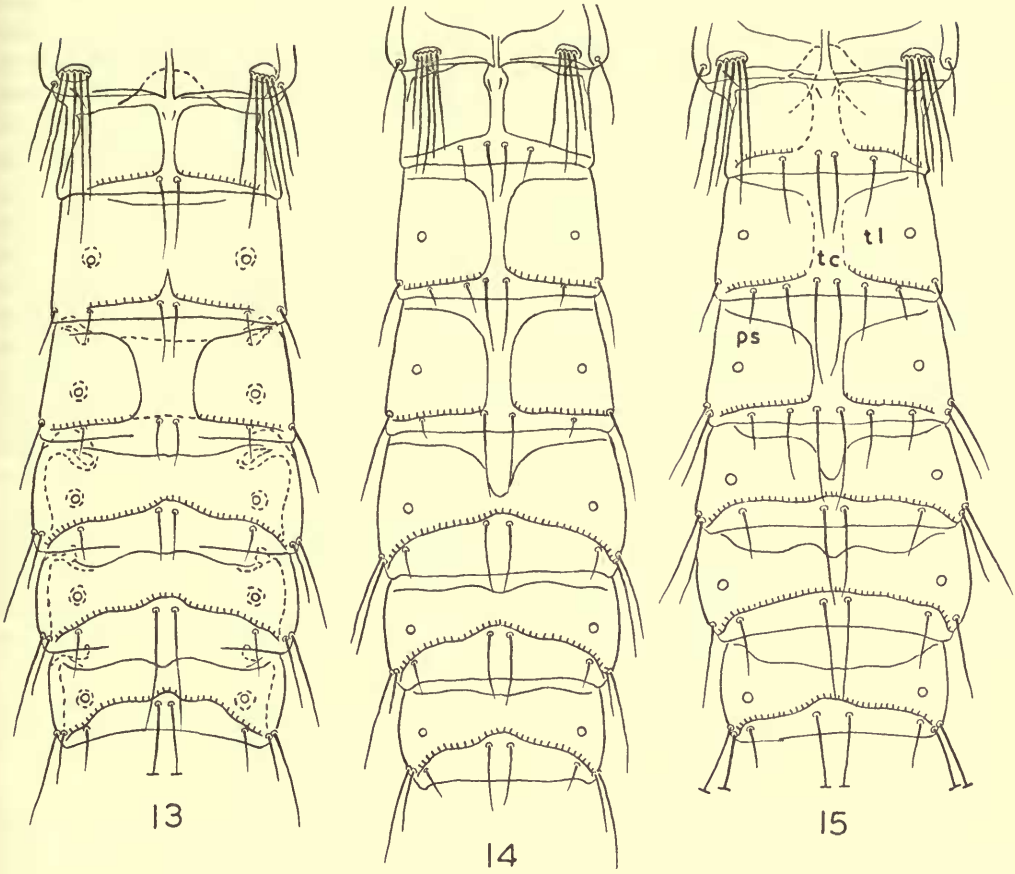
External genitalia. Male. The basal apodeme, parameres and mesosome of *signatus* and *lepidus* are essentially similar (Text-figs 48, 49); so are those of *bicolor, dissourae, senegalensis* and *castaneus* (Text-figs 50–53). The shape of the sclerotized portion of the basal apodeme is characteristic, being wider anteriorly. A distinct waist is present in these species (Text-fig. 31), as also in most others, but is less evident in *lepidus* (Text-fig. 32). The mesosome and its sclerites are short and differ in shape and proportions. The parameres are short and curved (Text-fig. 52) or almost straight (Text-fig. 50); their apical portion is membranous, and differs in proportions. In *loculator* the parameres are much as in the foregoing species, but much larger (fig. 15 in Kumar & Tandan, 1968). The mesosome is also large, its sclerotization extensive and the median ventral sclerite thereof, called for convenience lower endomere (see Clay, 1956, for terminology), is fairly long. The basal apodeme is narrow anteriorly. The apodeme of *leucosoma* is much as in *lepidus* in shape; its mesosome is long and narrow, as in *maculatus*, and related species (nos 8–10), and the posterior portion is distinctive. In *maculatus, tantali, keleri* and *asiaticus* the three main components are extremely alike, differing mainly in size (Table VII) and proportions (Text-figs 54–57). The basal apodeme of these species is much as in *bicolor* and related species, but the mesosome is much longer and so is the lower endomere, which is more heavily sclerotized also. The parameres are also relatively long (Table VII). In the thirteen foregoing species, unlike the three following ones, the paramere has a distinct hook on its inner margin near or slightly anterior to the tip (Text-figs 52, 55).

The genitalia of *hardayali* and *fissomaculatus* are similar, differing mainly in proportions (figs 20–23 in Tandan & Kumar, 1969). Their characteristic parameres and mesosome differ from the corresponding parts of the thirteen foregoing species, but the basal apodeme is narrow anteriorly, as in *loculator*.

In all the fifteen foregoing species the outer articulation of the parameres with the basal apodeme is quite distinct. But in *ciconiae* the anteriorly slightly narrow basal apodeme merges imperceptibly into the parameres (fig. 43 in Clay & Hopkins, 1950). Its mesome and parameres are extremely long and distinctive.

Female. The female genitalia do not show sharp, clear-cut differences. There are narrow supra-vulval sclerites and larger and fainter inner genital sclerites; definitions of these terms are given in Clay (1957*a* and 1962 : 162) and Dhanda (1961 : 658). In four species only, *tantali* and related forms, which are feebly sclerotized species, there is a ring-like sclerotized spermathecal calyx; but *leucosoma*, which too is feebly sclerotized, lacks a sclerotized calyx.

Chaetotaxy. Tergal. Setae always present are; on II, 2 anterior tc, usually sh otherwise ml to lg; on IX-XI, 2 anterior and somewhat lateral and 4 posterior (2 tl + 2 tc), variable in length. On II-VIII 2 central setae are always present;



FIGS 13–15. Male, pterothorax and abdomen: 13, *A. lepidus*; 14, *A. bicolor*; 15, *A. senegalensis* sp. n.

lateral setae when present vary in number. The relative lengths of tc and tl setae on VIII and of the tc setae relative to the anterior margin of tergite IX-XI and the 2 anterior tergal setae on latter are important characters, especially for the male. Unfortunately they, and the number of central and lateral setae on tergum VIII, could not be studied in all the species and in both the sexes of the same species as either the series were in poor state or the setae were broken or twisted.

In *lepidus* and *signatus* the 2 tc on VIII are much longer than the tl setae and respectively reach or extend slightly (Text-fig. 16) or well beyond the 2 anterior setae on tergite IX-XI. In *bicolor, dissourae* and *castaneus* the tc and tl setae are equal or the tc are rather shorter also. In *bicolor* the tc setae usually reach the anterior margin of this tergite (Text-fig. 11) and fall well short of the anterior setae. In male of *dissourae* the tc setae cross the anterior margin slightly or rather more (Text-fig. 9). In the female of *dissourae* and in both sexes of *castaneus* (Text-fig. 10) the condition is as in *bicolor*. In the male of *senegalensis* (Text-fig. 33) the condition

is much as in *lepidus*, but in the female the tc are only slightly longer than the tl setae, and although the former cross the anterior margin of tergite IX-XI, they fall rather short of the anterior setae. In *loculator* the tc and tl setae are equal or the tc are slightly longer in the female. In the male the tc setae reach to or cross slightly this margin and fall well short of the anterior setae, but in the female these are longer and fall only slightly short of the anterior setae (Text-fig. 17). In *leucosoma* the tc are slightly longer than the tl setae (fig. 12 in Kumar & Tandan, 1968), but in their posterior extension resemble the male of *loculator*. In *tantali* and related species (nos 7, 9, 10) the tc are slightly shorter than the tl setae or both are equal; in male of *asiaticus* however, the tc are slightly longer also. In *maculatus* and *asiaticus* the tc setae extend considerably beyond the anterior margin of tergite IX-XI to fall much (Text-fig. 35) or slightly (Text-fig. 37) short of the anterior setae. In *tantali* and *keleri* (Text-fig. 36) the condition is as in the male of *dissourae*. In *fissomaculatus* the tc and tl setae are almost equal, but vary much in *hardayali*. In both species the tc setae either fall short of or just cross the anterior margin of tergite IX-XI, and fall well short of the anterior setae. In the male of *ciconiae* the tc are slightly shorter than the tl setae or both are equal; in the female the tc are rather longer. In *hopkinsi* also the tc setae are (seemingly) longer. While in *ciconiae* the tc setae reach to or even cross the anterior margin of this tergite, they fall well short of the anterior setae; and in *hopkinsi* the tc (partially broken in male, completely in female) setae cross the margin considerably in the male to (seemingly) reach the anterior setae (fig. 5 in Kumar & Tandan, 1968).

Of much taxonomic significance for the males of some species is the distance between and the proportions of the 2 central setae on tergum VIII (Table IV; Text-figs 9–11).

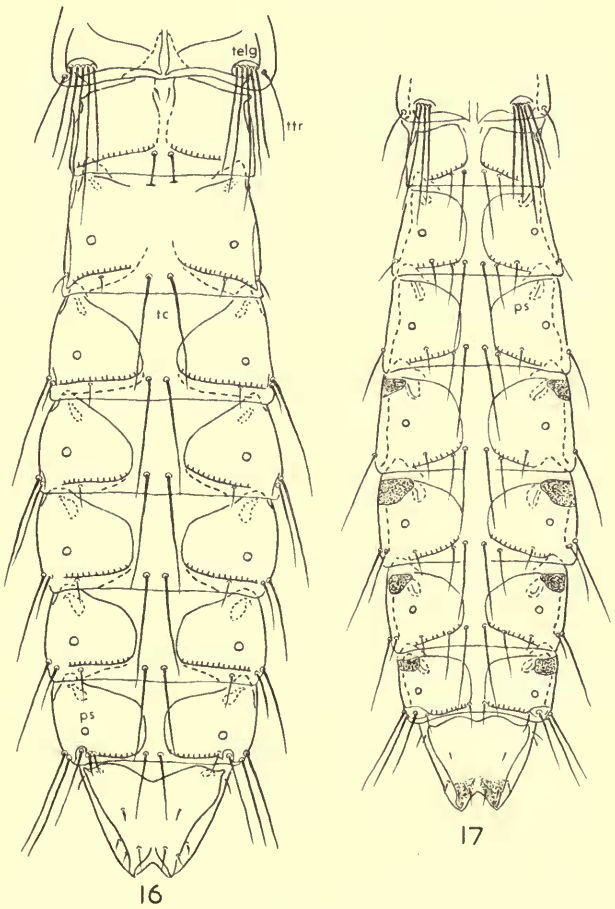
The definitive position of the tergal trichobothria on segment VIII is not always determinable in poorly or feebly sclerotized species, and in some well sclerotized species it is as follows:- Male. (1) In a notch of tergite: *lepidus*, *senegalensis* (probably) and *loculator* (Text-fig. 20). (2) As 1, but posterior to notch, less intense secondary sclerotization present: *fissomaculatus* (Text-fig. 23) and *hardayali*. (3) On tergite: *bicolor* (Text-fig. 22), *dissourae*, *castaneus*; probably *senegalensis*, *leucosoma*, *keleri* and *maculatus*; in *ciconiae* (Text-fig. 21) and *hopkinsi* well on tergite. Female. Always below tergite, on less intense (secondary) sclerotization. (1) In a notch: *lepidus*, *bicolor* (Text-fig. 27), *dissourae*, *loculator* (Text-fig. 25), *ciconiae* (Text-fig. 26) and *hardayali*. (2) Surrounded by sclerotization (no notch evident): *senegalensis*, *castaneus*, probably *leucosoma*, *keleri*, *fissomaculatus* (Text-fig. 24) and *hardayali*.

The 1+1 characteristic post-spiracular setae are mostly present on terga III-VII, but in *hardayali* and *fissomaculatus* on terga II-VII. Their length varies and there are no contiguous sensilli.

Pleural. On II, absent and on III, 1+1, extremely constant. On IV-V or VI the number varies greatly; on VI or VII-VIII the common number is 4+4. Absence of any great differences in the proportions and position of the pleural setae on IV and V in the female has much significance.

Sternal. This is relatively less variable. In the male sterna II and III normally have 2 sl + 2 sc setae, variable in length. Their proportions relative to each other,

more especially of those on II, are important characters. Sternum IV (fig. 9 in Kumar & Tandan, 1968) has only 2 sc setae in 14 species, (nos 1–13, 15) but in *bicolor* and *leucosoma* these may be absent also. In *hardayali* and *hopkinsi* sl setae are also present on sternum IV. The sc are m or sh and usually difficult to locate, but are ml to lg in *ciconiae* (Text-fig. 28) and ml and fine in *signatus*. The sl are m in *hardayali* and lg in *hopkinsi*, (fig. 1 in Kumar & Tandan, 1968). On sternum V also 2 sc setae are present in all species, usually m or sh, as on IV, but ml in *signatus* and ml to lg in *lepidus*, and in both fine. In *hopkinsi* (lg) sl setae are also present on V, while in *ciconiae* (ml to lg) and *fissomaculatus* (m or sh) setae outer to sc setae are not strictly sl in position. Besides these normal ones, additional sp or sh setae may also be present on sterna III-V, but these have no taxonomic significance. Sternum VIII has normally 2 central lg setae in 11 species, but in the remaining 5 their number is more, thus: *signatus*, 4; *lepidus*, 5–6; *ciconiae*, 5–8 (Text-fig. 28); *fissomaculatus* 4–6; *hopkinsi*, 3 (fig. 6 in Kumar & Tandan, 1968).

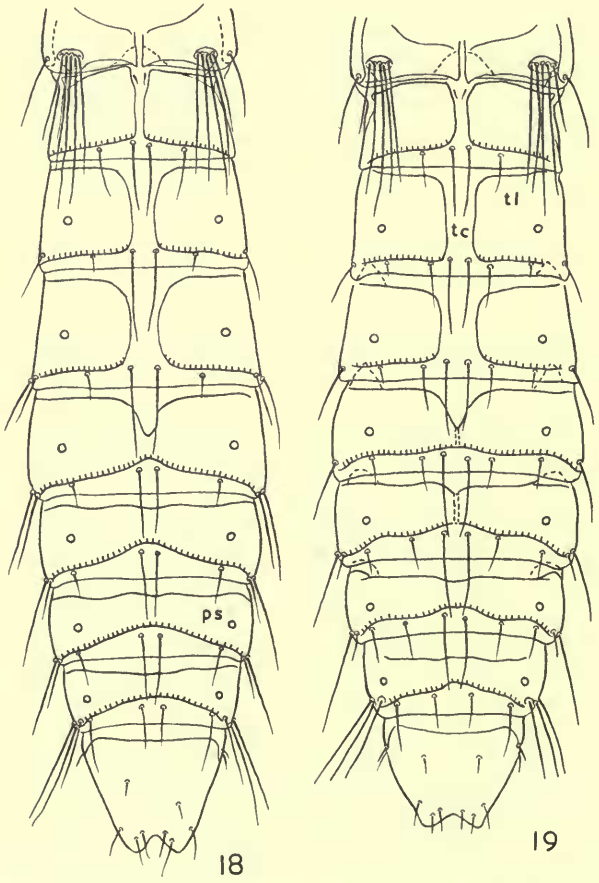


FIGS 16, 17. Female, pterothorax and abdomen: 16, *A. lepidus*; 17, *A. loculator*.

In the females of nine species the normal count of setae on sterna II and III is the same as in their males, but it differs in *signatus*, *lepidus*, *castaneus*, *ciconiae*, *hopkinsi*, *hardayali* and *fissomaculatus*. In these seven species sterna II and III either tend to or have more than 4 setae. This difference in number from the male count deserves emphasis for even striking differences have been observed in the sternal chaetotaxy of *Ardeicola* from the Threskiornithidae and these have proved to have much evolutionary significance. Sterna IV and V are like those of their males, excepting *ciconiae* in which the number and size differ. Sternum VIII always has 2 central lg setae.

In both the sexes the number varies on sterna VI and VII, but the length is usually ml to lg.

The position of the 3+3 anal setae each side relative to each other is important, unlike their proportions which differ slightly only. In the male anal seta *a* is ventral and usually the most anterior; *p* is most dorsal and both these tend to be directed posteriorly. Seta *m*, between *a* and *p*, is associated with the invagination forming



FIGS 18, 19. Male, pterothorax and abdomen: 18, *A. dissourae* sp. n., 19, *A. castaneus*.

the external genitalia and is directed more towards the midline. Except in three species, the alveolus of *m* is either slightly outer to that of *p* or the alveoli of both are in line (Text-fig. 45). In *hardayali* and *fissomaculatus* (Text-figs 46, 47), *p* is inwards and *m* is always outer. In all foregoing species the distance between *m* and *p* differs. Lastly, and only, in *ciconiae* (Text-fig. 44) *m* is inner relative to *p*. In the female of *lepidus* (Text-fig. 39) and *signatus* the alveoli of the three, inner, middle and outer, anal setae are in a straight line. In all other species the position of anal setae *i* and *o* relative to each other is more or less constant, as is also that of anal seta *m* relative to *o*; however, the position of *m* relative to seta *i* varies considerably. Seta *m* is anterior to seta *i* in *hardayali* (Text-fig. 42), but is either at same level or even slightly posterior to the latter in *ciconiae* (Text-fig. 43). Both these conditions are present in *fissomaculatus*. In all other species seta *m* is always posterior to *i*, although the difference in their levels differs (Text-figs 38, 40, 41).

In both sexes the position of the 2 setae *d* of each side relative to each other also shows slight but significant differences (Text-figs. 38–47). Further, the two groups, setae *d* and anal setae, of each side, show significant differences in position relative to each other.

On the terminal segment in the male there are each side 2–6 (total 3–11) anterior and submarginal setae. On the basis of their proportions and position these are distinguishable into three types, referred to as *a*, *p* and *v* (Text-figs 33, 36). Setae *a*, 1+1, are present in 12 species, dorsally, on or off or on edge of tergite IX-XI, ml to lg, slightly shorter and thinner than *v*. Species lacking *a* are *lepidus*, *signatus* and *castaneus*; in *dissourae a* may be present or absent. Setae *v*, 1–4 each side (total 2–8), lg, are ventro-lateral or ventral. Setae *p*, 1+1, are lateral, between *a* and *v*. These are always much shorter and finer than *v*, usually than *a* also, and unlike both are 'glassy' translucent in appearance. The proportions of *a* and *p* are taxonomically important.

In the female and present in the same position there are 1–6 each side (total 3–11) setae (Text-fig. 59). Setae *a*, 1+1, are present in all species, sh and fine, off tergite or on its edge. Setae *p*, 1+1, and *v*, 1–4 each side (total 2–7). Usually *p* and *v* are sp, but *p* may be sh also

Further, posterior to these setae there are marginal and submarginal setae, usually lg in the male and sp in female. Their number is usually in the male 2–7 each side (total 4–13), exceptionally 0–1 (1–2), and in the female 3–10 (6–16) exceptionally 1–3 (4).

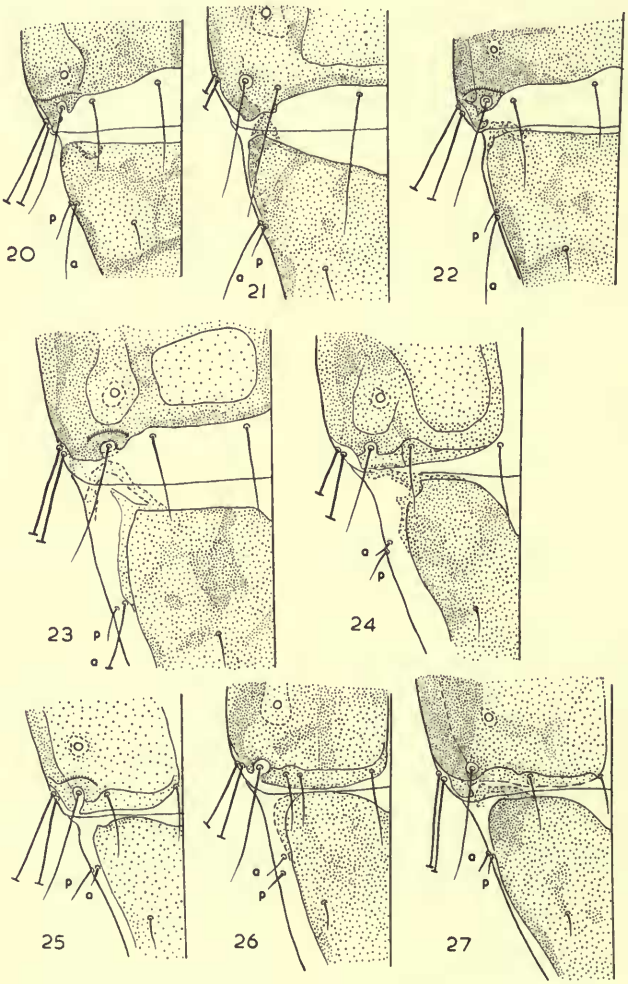
The species can be diagnosed by a combination of the above characters, which may therefore be considered as of specific value. Perhaps none of them is free from individual variation, which may range from slight to considerable, especially in the relative position of setae *a*, *v* and p (Text-figs 20–27, 33, 59).

The *ARDEICOLA* species of the Ciconiidae

For those homologous setae present on thorax and abdomen of all species, described as constant in the previous sections, only the length, position and deviation in number from norm have been given: the latter is expressed as one out of five,

but abbreviated 1/5 for example. The 2 setae of the marginal row closest to the midline on terga II-VIII, the composite tergum IX-XI, as also on sterna II-V and sternum VIII, are distinctive and differ strikingly in shape and proportions from the lateral setae, if the latter are present. Hence following Kéler (1938: 419), the terms tergocentral, tergolateral, sternocentral and sternolateral have been used. Explanations of abbreviations used in describing the length and position of important setae in the text and figures are given on page 158.

It was not always possible to count all the setae of the number of specimens given. In such cases the sign of interrogation (?) has been used indicating that the presence or absence of the seta(e) in question remain open. No figure has been given



FIGS 20–27. Abdominal trichobothrium. 20–23, Male: 20, *A. loculator*; 21, *A. ciconiae*; 22, *A. bicolor*; 23, *A. fissomaculatus*. 24–27, Female: 24, *A. fissomaculatus*; 25, *A. loculator*; 26, *A. ciconiae*; 27, *A. bicolor*.

when the count was constant, there being no individual variation. Figures in parantheses denote the number of specimens, and $\bar{x}$ denotes the mean. Measurements have usually been corrected to two decimal places. All characters discussed in the previous section have been omitted from this section. If a character agrees in the two sexes, it has been omitted from the description of the female.

Five species, *leucosoma*, *loculator* male, *hopkinsi*, *fissomaculatus* and *hardayali*, have been recently described fully (Kumar & Tandan, 1968; Tandan & Kumar, 1969) and only that information necessary for comparison with other species, and not given earlier, has been included here.

Neotypes have been designated for two species described by Nitzsch and one by Giebel; these species were based on specimens in the Nitzsch collection. It is now known that, with the exception of the material belonging to the *Goniodes*-complex and the Trichodectidae, the collection was destroyed during the 1939–1945 War.

1. ***Ardeicola lepidus*** (Nitzsch, 1866)

(Text-figs 4, 6, 7, 13, 16, 30, 39, 49; Tables I, IV)

Lipeurus lepidus Nitzsch, 1866 : 383. Host: *Anastomus coromandelicus*.

This species is closely related to *signatus* and is distinguished from it in both sexes by its larger size, wider head, proportions of the dorsal anterior plate and higher C.I., and in the male by the details of the genitalia (Text-fig. 49). There is considerable difference in the shape of the female abdominal segments IV–VII and their lateral tergites.

Chaetotaxy. Male (4). Inner pronotal ml to almost lg. Tergal: II, ant. tc sh to almost ml. Post. II–VII, 2 tc; VIII, 4 tl + 2 tc (2), 3+2 (1), 3+? (1); IX–XI, ant. sh, post. tl sh to ml and tc sh, tc and tl equal or tc slightly shorter; *b*, ml on tergite. Post-spiracular: III, 0+1 (1/4); III, IV, sh; V, VI, ml; VII, ml to almost lg. Pleural: IV, 4 (3), 5 (1); V, 4+4; VI, 4+4 (3), 4+3 (1); VII, 4+5 (1/4); VIII, 3+3 (1/4); *p*, sh; *v*, 2+2; marginal and submarginal, 5–7 (total 11–13). Meso- and meta-sternal, 4–5 and 4, respectively. Sternal: II, all lg, sl slightly longer than sc; III, normal (2), 4 sl + 2 sc (1), sl ml, sc sh and wide apart; VI, 8–11; VII, 10 (3); *d*, ml to lg.

Female (5). Tergal: As in male but on VII, 3 tc (1); VIII, 2 tl + 2 tc (3), 4+2 (1); IX–XI, 3 tl + 2 tc (1/5), tc and tl equal or tc slightly longer; *b*, sh well away from or near edge of tergite. Post-spiracular as in male, but on VI, VII almost lg. Pleural: III, 1+? (1/5); IV, 2–4, total 5–8, $\bar{x}$ 6·50 (4); V, 3–6, total 7–9, $\bar{x}$ 8·60 (5); VI, 3–5, total 6–10, $\bar{x}$ 8·00 (5); VII, 3+4 (1/4); *v*, 1+1 (3), 2+1 (1); marginal and submarginal, 8–10 (total 17–19). Meso- and meta-sternal 4 and 4–5 respectively. Sternal: II, all lg, 9 (1), 10 (1), 2 are sc rest sl; III, 2 sc sh (2), 2 sl + 2 sc + 1 sl (1) all sh, 9 (1) sh to ml, fine; VI, 9–10; VII, 12–14; between VII and VIII, 2–6 sh; *d*, sh to ml, 1+2 (1/4). Sp setae on or near margin of vulva, 14–15 (4 central, 5–6 (total 10–11) lateral); on sub-genital plate, 4 or more sp setae.

Material examined.

NEOTYPE ♂ of *Lipeurus lepidus* Nitzsch, from the type-host *Anastomus oscitans* (Boddaert), by present designation, slide no. 19804a, India: Moirang, Manipur, 18.i.1952 (*R. Meinertzhagen*), BMNH.

Neoparatypes. 24 ♂ (4 dissected), 27 ♀ (1 dissected), same data as neotype (slide nos 4821, 9078, 19104) or from India: Unao, U.P., 1949 (*B. K. Tandan*) slide no. 65), BMNH.

Table 1. Measurement in millimetres of Ardeicola species, mounted in Canada balsam

		Male			Female					
		lepidus (4)		signatus(1)	lepidus (4)		signatus (2)		loculator (2)	
		Range	Mean		Range	Mean	Range	Mean	Range	Mean
Head	L	0.73-0.76	0.75	0.73	0.76-0.83	0.80	0.80, 0.82	0.810	0.93, 0.94	0.935
	L_1	0.35-0.37	0.36	0.37	0.39-0.43	0.40	0.43, 0.46	0.445	0.48, 0.51	0.495
	L_2	0.36-0.41	0.39	0.36	0.37-0.41	0.40	0.37, 0.36	0.365	0.43, 0.44	0.435
	B	0.46-0.48	0.47	0.42	0.51-0.60	0 54	0.46, 0.47	0.465	0.58, 0.59	0.585
Prothorax	L	0.18-0.21	0.19	0.14	0.19-0.21	0.20	0.15, 0.14	0.145	0.19, 0.21	0.200
	B	0.35-0.39	0.36	0.33	0.39-0.43	0.42	0.36, 0.37	0.365	0.41, 0.43	0.420
Pterothorax	L	0.40-0.42	0.41	0.35	0.37-0.42	0.40	0.36, 0.37	0.365	0.41, 0.44	0.425
	B	0.48-0.53	0.50	0.44	0.60-0.65	0.62	0.47, 0.46	0.465	0.57, 0.62	0.595
Abdomen	L	1.66-1.74	1.69	1.73	2.16-2.37	2.25	2.09, 2.13	2.110	2.70, 2.84	2.770
	B	0.50-0.57	0.53	0.50	0.66-0.71	0.69	0.61, 0.54	0.575	0.76, 0.82	0.790
	T.l.	3.00-3.13	3.07	2.95	3.50-3.79	3.67	3.40, 3.46	3.430	4.25, 4.44	4.345
	C.l.	0.61-0.64	0.62	0.57	0.62-0.73	0.67	0.57, 0.58	0.575	0.61, 0.62	0.615

L, length; L_1, length of preantennal region; L_2, length of postantennal region; B, breadth; T. l., total length; C. l., head index.

2. *Ardeicola signatus* (Piaget, 1880)

(Text-figs 5, 29, 48; Tables I, IV)

Lipeurus signatus Piaget, 1880 : 310, pl. 25, fig. 7. Host: *Anastomus lamelligerus*.

The available specimens of *signatus*, which include the original Piaget material also, are of suboptimal quality and unfit for a critical study, hence the setal count of many was not possible to determine. Its difference from *lepidus* are given under the latter species.

Chaetotaxy. Male (1). Inner pronotal ml. Tergal: II, ant. tc ml. Post. On II–VII, IX–XI, and post-spiracular as in *lepidus*, but latter on VI, 1+2 and lg, VIII, 3 tl + 2 tc. Pleural: IV, 4; V, 4+3; VI, 8; *p*, 1+0 ml; *v*, 2+2; marginal and submarginal, 5+5. Meso- and meta-sternal, 4 and 4 or 5, respectively. Sternal: II, all lg, sc and sl almost equal in length; III, sl ml, sc sh; VI, 10; VII, 11; *d*, ml to lg.

Female (2). Inner pronotal slightly longer than in male. Tergal: II, ant. tc ml to lg. Post. II–VII as in *lepidus*; VIII, 3 and 4 tl + 2 tc; IX–XI, ant. 1 + 0 (1/2), post., ml all asymmetrical, tl very slightly longer than tc; *a*, 0+1 (1/2); *b*, sh. Post-spiracular: III, ml; IV, ml to almost lg; V, almost lg; VI, almost lg to lg; VII, lg. Pleural: IV, 8, 7; V, 7, 9; VI; 8, 9; VII, 5+5, 5+3; VIII, 4+2 (1/2); *p*, 1+0 (1); *v*, 4, 2; marginal and submarginal, 7+4, 8+7. Meso- and meta-sternal, 3, 5 and 4, respectively. Sternal: II, 8 (1) all lg; III, 5 sh fine; VI, 11; VII, 11, 12; between VII and VIII, 2 lg; *d*, ml to lg. Sp setae on or near margin of vulva, 19 (6 central, 6–7 (total 13) lateral); on sub-genital plate, 9–10 sp setae.

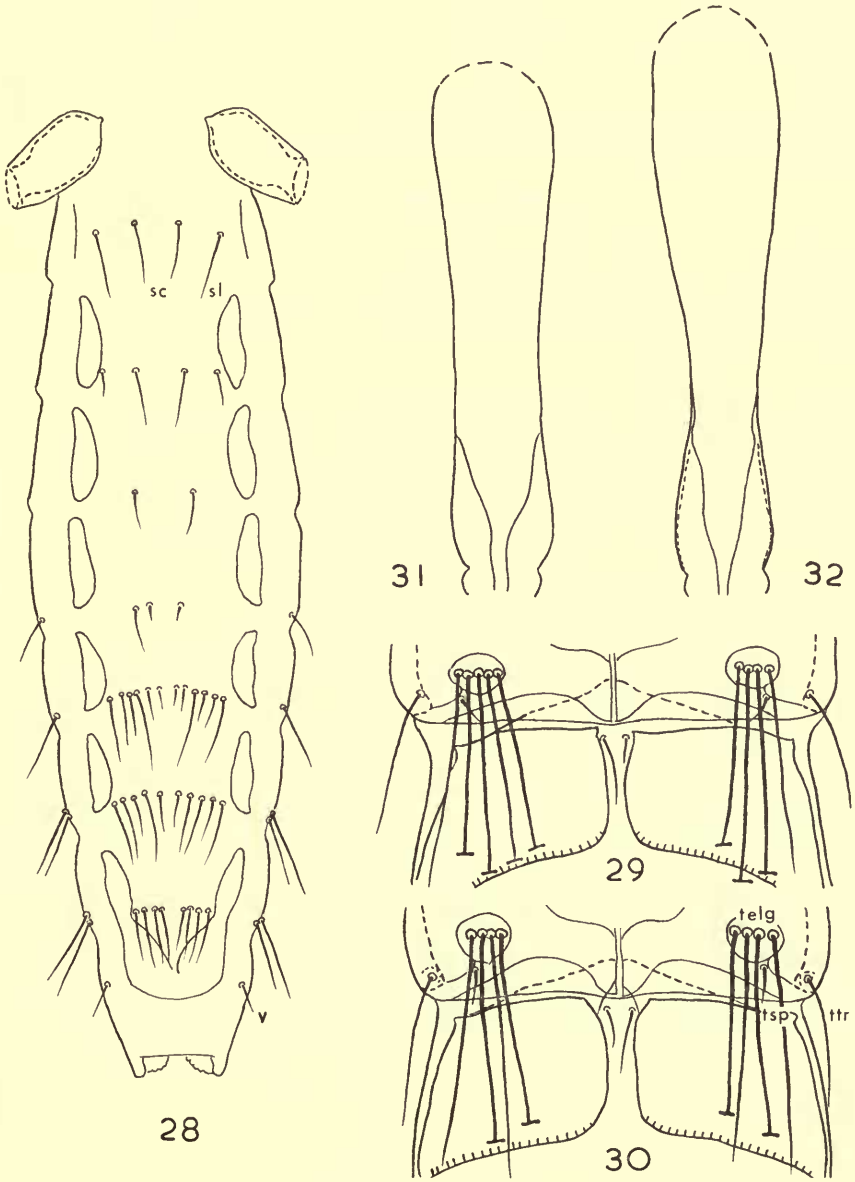
In the female most of the head and thoracic setae are longer than the same ones in the male, and those of both sexes are slightly longer than in *lepidus*.

Material examined.

Piaget's syntypes: 2 ♂, 3 ♀ (no locality) from *Anastomus lammelligerus*.

LECTOTYPE ♂ of *Lipeurus signatus* Piaget, by present designation, slide no. 915, BMNH.

Paralectotypes. 1 ♂, 3 ♀, slides nos 915, 914, BMNH.



FIGS 28–32. 28–30, *A. ciconiae*: 28, Male, abdomen, ventral (anal setae and setae in genital region not shown); 29, 30, posterior pteronotal setae and abdominal segment II, male: 31, 32, Basal apodeme: 31, *A. signatus*; 32, *A. lepidus*.

Other material. From *Anastomus l. lamelligerus* Temminck, KENYA: 1 ♂, 2 ♀, iv. 1936 (*R. Meinertzhagen*, 7608), BMNH.

The four species to follow (3–6) are closely related. This is indicated by their general habitus, shape of tergites, especially the deep incision in the anterior margin of tergite V in the male and of the slight to greater emargination in the anterior margin of tergite IX-XI in the female, and the basically similar male external genitalia.

Ardeicola bicolor is more closely related to *dissourae* and both are readily separated from *senegalensis* and *castaneus* by the tergal chaetotaxy.

3. *Ardeicola dissourae* sp. n.

(Text-figs 2, 9, 18, 45, 50; Tables II, IV)

Type-host: *Dissoura episcopus microscelis* (G. R. Gray).

The species on the African subspecies of *D. episcopus* is not *castaneus* (Piaget) but a new form here described.

A. dissourae is distinguished from *bicolor* by its slightly larger average size (Text-fig. 1) and shape of head and terminalia; in the male by the relatively narrow and shallow incision in the anterior margin of tergite V, the 2 considerably thicker and somewhat longer tc setae on VIII (Text-figs 9 and 11) and details of the mesosome; and in the female by the wider genital opening, the less pronounced curvature of the vulva and the general shape of supra-vulval sclerites.

CHAETOTAXY. MALE (6). Inner pronotal almost lg to lg. Telg setae, 5+6 (1/6). Tergal: II, ant. tc sh. Post. II, 2 tl + 2 tc (3), 1+2 (2), 1 tl (1) as setae short?; III, 2 tc (5) and ? (1); IV–VII, 2 tc (on V adjoining the tc 1 m also in 1 male); VIII, 2 tl + 2 tc (4) and 2 + 1 (2) as 1 tc ?; the 2 tc close together (Table IV) as in *bicolor*, but thicker and longer; IX–XI, ant. sh, post. ml or tc lg also and slightly longer than tl; *a*, almost lg to lg, 1+1 (1), 0+1 (1), 0 (3); *b*, ml to almost lg, well on tergite. Post-spiracular: on II, 1+0 (1/6); III, IV, sh; V, sh to ml; VI, ml; VII, lg. Pleural: IV, 3–4, total 6–7, $\bar{x}$ 6·16 (6), 3+3 (5/6); V, 3–4, total 6–8, $\bar{x}$ 6·50 (6), 3+3 (4/6); VI, 3–4, total 6–8, $\bar{x}$ 7·66 (6), 4+4 (5/6); *p*, normally sh or ml also; *v*, 2–4; marginal and submarginal, 1–2 (total 2–4). Mesosternal, 2 (3), 3 (2); metasternal, 1+1. Sternal: II, all lg, normal (5), sl longer than sc; III, sl usually sh fine or ml to lg also, sc sh to almost ml; VI, 5–7; VII, 6–8; *d*, ml to lg.

FEMALE (10). Inner pronotal sh to almost ml. Tergal: II, 2 tl + 2 tc (6), and 2+0 (1), 1+0 (1), 1+1 (1) as seate short ?; III–V (10) and VI, VII (9), 2 tc; VIII, 2 tl + 2 tc (8), 3+2 (1), 2+? (1); IX–XI, ant. sh, post. sh to ml, tl longer than tc; *b*, sh off tergite or near its edge. Post-spiracular: III (1/10), VII (1/10), 1+0; in same female, III, IV, 0, and V, 1+0; III, sh to almost ml; IV, V, sh to ml; VI, ml to lg; VII, lg. Pleural: IV, 2–4, total 5–8, $\bar{x}$ 6·80 (10); V, 3–6, total 6–11, $\bar{x}$ 7·20 (10), 4+4 (3/10); VI, 4+4 (9), total 7–8, $\bar{x}$ 7·90 (10); VII, 3+4 (2/10); *p*, 0+1 (1/10); *v*, 2–4 (7), 0–1 (2); marginal and submarginal, 1–5 (total 4–9). Mesosternal, 2 (4), 3 (5), 4 (1); metasternal, 2 (5), 3 (2); on both 1+1 (3). Sternal: II, sl much longer than sc, 3 sl + 2 sc (1) as 1 extra ml sl on one side; III, sl ml to lg, sc sh to ml; VI, VII, 6–8; between VII and VIII, 1–3 sh; *d*, ml to lg. Sp setae on or near margin of vulva, 17–21 (4–8 central, 5–8 (total 10–13) lateral); on sub-genital plate, 4–6 sp setae.

Width of genital opening 0·232–0·245 mm, $\bar{x}$ 0·238 (7); curvature of vulval margin less pronounced.

MATERIAL EXAMINED.

Holotype ♂, from *Dissoura episcopus microscelis* (G. R. Gray), slide no. 4814a, SUDAN (*R. Meinertzhagen*), BMNH.

Paratypes. Some data as holotype, 5 ♂ (1 dissected), 10 ♀, BMNH.

Table II. Measurements in millimetres of Ardeicola species mounted in Canada balsam

		Male						Female			
		dissourae (6)			senegalensis (6)			dissourae (10)		senegalensis	
		Range	Mean	Holotype	Range	Mean	Holotype	Range	Mean	Paratypes	Mean
Head	L	0.75-0.77	0.76	0.76	0.84-0.87	0.86	0.86	0.79-0.87	0.83	0.89, 0.90	0.895
	L_1	0.37-0.41	0.40	0.41	0.43-0.46	0.44	0.45	0.41-0.46	0.43	0.47, 0.48	0.475
	L_2	0.35-0.37	0.36	0.35	0.41-0.43	0.42	0.41	0.37-0.41	0.40	0.42, 0.42	0.420
	B	0.43-0.44	0.43	0.44	0.50-0.53	0.51	0.51	0.46-0.50	0.47	0.54, 0.55	0.545
Frothorax	L	0.17-0.18	0.17	0.18	0.19-0.22	0.21	0.19	0.17-0.19	0.18	0.21, 0.20	0.205
	B	0.32-0.33	0.32	0.33	0.40-0.41	0.40	0.40	0.32-0.39	0.36	0.41, 0.43	0.420
Pterothorax	L	0.40-0.41	0.40	0.41	0.39-0.41	0.40	0.39	0.37-0.44	0.41	0.43, 0.42	0.425
	B	0.43-0.46	0.44	0.43	0.53-0.57	0.54	0.53	0.50-0.57	0.53	0.58, 0.59	0.585
Abdomen	L	1.77-1.88	1.83	1.88	1.73-1.99	1.87	1.87	2.28-2.72	2.48	2.49, 2.53	2.510
	B	0.48-0.53	0.51	0.53	0.54-0.58	0.57	0.56	0.59-0.69	0.65	0.66, 0.71	0.680
	T. l.	3.14-3.24	3.19	3.24	3.18-3.47	3.32	3.31	3.70-4.20	4.01	4.02, 4.06	4.040
	C. I.	0.51-0.58	0.56	0.58	0.58-0.60	0.59	0.59	0.56-0.60	0.58	0.60, 0.61	0.605

L, length; L_1, length of preantennal region; L_2, length of postantennal region; B, breadth; T. l., total length; C. I., head index

4. ***Ardeicola bicolor*** (Piaget, 1888)

(Text-figs 3, 11, 14, 22, 27, 51; Tables III, IV)

Lipeurus bicolor Piaget, 1888 : 157, pl. 4, fig. 1. Host: *Tantalus senegalensis*. [Error.]

Piaget gave *Tantalus* (= *Ephippiorhynchus*) *senegalensis* as the host of *bicolor* and in the check list (Hopkins & Clay, 1952) also this bird is given as its host. But later Hopkins & Clay (1953 : 447) changed the host to *Sphenorhynchus abdimi*, and after examining the syntypes and series from *S. abdimi* we agree with them in regarding *S. abdimi* as the type-host of *bicolor*.

In 2 males and 2 females of *bicolor*, out of 7 and 13 respectively (excluding the syntypes), tergum III has besides the 2 tc setae, 1 tl seta also which closely resembles in proportions the 2 tl setae on tergum II. Whereas in 5 males out of 6 (1 being unfit for counting) and all the 10 females of *dissourae* tergum III has only 2 tc setae. Thus, the average number of setae on tergum III is greater in *bicolor* than in *dissourae*. This difference, even in the small numbers examined, with other differences shows the populations of *Ardeicola* on *S. abdimi* and *D. episcopus microscelis* to be distinct.

Chaetotaxy. Male (7). Inner pronotal ml. Telg setae, 5+4 (1/6). Tergal: II, ant. tc sh. Post. II, 2 tl + 2 tc (6) and 2 tc (1) as tl ?; III, 2 tc (5), 1 tl + 2 tc (2); IV–VII, 2 tc; VIII, 2 tl + 2 tc, the 2 tc close together (Table IV); IX–XI, ant. sh, post ml, tc and tl equal or tc slightly longer; *a*, 0+1 (2), 1+1 (3) almost lg to lg; *b*, sh to lg, on tergite, of two sides may be asymmetrical, 1+0 (1/5). Post-spiracular: III, sh; IV, sh to ml; V, VI, ml; VII, almost lg. Pleural: IV, 2–4, total 5–8, $\bar{x}$ 6·66 (6); V, 3–4, total 6–8, $\bar{x}$ 6·66 (6); VI, 4+4 (5), 2+4 (1); VII, 4+2 (1/6); VIII, 3+2 (1/6); *p*, sh fine; *v*, 1–2 (total 3–4); marginal and submarginal, 2–3

Table III. Measurements in millimetres of Ardeicola species mounted in Canada balsam

		Male				Female			
		bicolor (5)		castaneus (8)		bicolor (12)		castaneus (9)	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Head	L	0.74-0.78	0.76	0.76-0.83	0.80	0.76-0.86	0.83	0.82-0.86	0.83
	L_1	0.39-0.41	0.40	0.40-0.43	0.41	0.41-0.44	0.43	0.41-0.44	0.43
	L_2	0.35-0.37	0.36	0.35-0.40	0.39	0.35-0.41	0.40	0.39-0.43	0.40
	B	0.42-0.43	0.42	0.44-0.47	0.46	0.43-0.48	0.46	0.48-0.51	0.50
Prothorax	L	0.14-0.19	0.17	0.14-0.18	0.15	0.15-0.21	0.18	0.15-0.19	0.17
	B	0.30-0.35	0.32	0.33-0.36	0.35	0.33-0.36	0.35	0.36-0.40	0.38
Pterothorax	L	0.36-0.42	0.39	0.36-0.43	0.40	0.39-0.44	0.42	0.37-0.41	0.39
	B	0.42-0.47	0.44	0.43-0.48	0.46	0.46-0.55	0.50	0.48-0.55	0.51
Abdomen	L	1.77-1.91	1.84	1.69-1.88	1.74	2.06-2.63	2 48	2.30-2.54	2.43
	B	0.42-0.50	0.46	0.48-0.55	0.50	0.44-0.58	0.52	0.59-0.71	0.65
	T 1.	3.02-3.25	3.17	2.96-3.20	3.10	3.35-4.08	3.87	3.73-4.01	3.82
	C.I.	0.55-0.57	0.56	0.55-0.60	0.58	0.55-0.59	0.57	0.57-0.61	0.59

L, length; L_1, length of preantennal region; L_2, length of postantennal region; B, breadth; T.1., total length; C.I., head index

(total 4–6). Mesosternal, 2 (4), 2+1 and 0 (2); metasternal, 2. Sternal: II, all lg, normal (2), 3 sl + 2 sc (1), sl usually much otherwise slightly longer than sc; III, sl ml fine, sc sp or sh; VI, VII, 6–8; *d*, sh to almost lg.

Female (13). Inner pronotal, sh to ml. Telg setae, 5+4 (1/10). Tergal: II, 2 tl + 2 tc (9); III, 2 tc (11), 1 tl + 2 tc (2); IV–VII, 2 tc; VIII, 2 tl + 2 tc (8), 3+2 (2); IX–XI, ant. 0+1 (1) and post. sh, tl on edge of or on tergite; *b* sh or sp off tergite; a seta like *b* may be present anterior to it on one side. Post-spiracular as in male, but on IV, sh and on V, sh to ml. Pleural: IV, 3–4, total 6–8, $\bar{x}$ 7·60 (10), 4+4 (8); V, 3–5, total 7–9, $\bar{x}$ 8·00 (10), 4+4 (8); VI, 4+4; *v*, 1–3 (total 3–6); marginal and submarginal, 3–6 (total 7–11). Meso- and meta-sternal, 0–2 (total 1–4); on both, 1+1 (1/3). Sternal. II (6), III (4), VI and VII as in male, but on II sl and sc equal or sl slightly longer, on III sl lg and sc sh, on VII also 9, and between VII and VIII, 1–2 ml; *d*, ml to lg. Sp setae on or near margin of vulva 14–21 (4–9 central, 4–7 (total 8–14) lateral); on sub-genital plate, 4–7 m setae.

Width of genital opening 0·209–0·216 mm, $\bar{x}$ 0·212 (7); curvature of vulval margin pronounced.

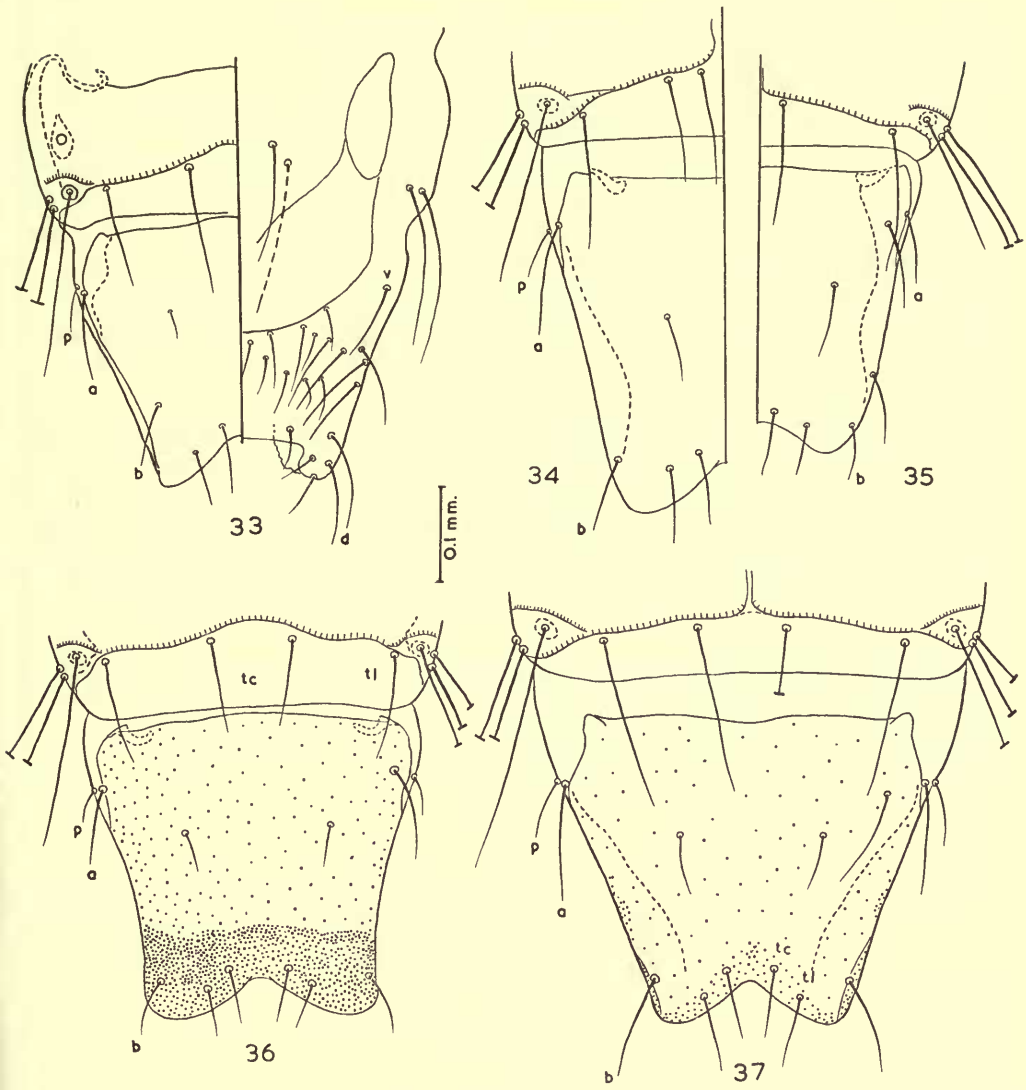
Material examined.

Piaget's syntypes: 2 ♂, 4 ♀ (no locality) of which the given host, *Tantalus senegalensis*, is wrong.

LECTOTYPE ♂ of *Lipeurus bicolor* Piaget, by present designation, slide no. 795, BMNH.

Paralectotypes of *Liperuus bicolor* Piaget, 1 ♂ 4 ♀, slides nos 795, 796, data as above, BMNH.

From the type-host, *Sphenorhynchus abdimi* (Lichtenstein), 6 ♂, 10 ♀, Kenya, Cameroons (Zoo) and N. Rhodesia (now Zambia), BMNH. 1 ♂, 3 ♀, Sudan, Ethiopia, U.S. National Museum, Washington, D.C.



FIGS 33–37. Male terminalia: 33, *A. senegalensis* sp. n. (tc seta on VIII on right-hand side shown by broken line); 34, *A. tantali*; 35, *A. maculatus*; 36, *A. keleri* sp. n.; 37, *A. asiaticus* sp. n.

5. *Ardeicola senegalensis* sp. n.

(Text-figs 15, 33, 38, 52; Tables II, IV)

Type-host: *Ephippiorhynchus senegalensis* (Shaw).

A. senegalensis is at once distinguished from *castaneus* by its tergal chaetotaxy. Other differences are in the size of the body, in the male in the distance between the 2 tc setae on VIII

(Table IV) and their proportions, shape of anterior margin of tergite IX–XI, and in the proportions of posterior sclerites of external genitalia, and in the female (perhaps) in the shape of supra-vulval sclerites.

CHAETOTAXY. MALE (6). Inner pronotal ml. Telg setae, 5+6 (1/6). Tergal: II, ant. tc sh. Post. II, 2 tl + 2 tc (5), and 2 tc (1) as tl?; III, 2 tl + 2 tc; IV, as on II; V–VII, 2 tc; VIII, 2 tl + 2 tc (4), 3+2 (2), the 2 tc setae thicker and much longer than in *castaneus*, (Text-figs 10, 33) and the distance separating them is the maximum among the four related species (Table IV); IX–XI, ant. sh, post ml, 3 tl + 2 tc (1/6); *a*, 1+1 lg; *b*, lg well on tergite. Post-spiracular: III, IV, ?+1 (1); III, IV, sh; V, ml; VI, ml to lg; VII, almost lg to lg. Pleural: IV, 2–4, total 5–8, $\bar{x}$ 6·83 (6), 4+4 (3); V, 4+4 (5), 3+3 (1), $\bar{x}$ 7·66 (6); VI, 4+4; *p*, 1+1 ml to almost lg; *v*, 2+2 (5), 1+1 (1); marginal and submarginal, 2–4 (total 5–7). Mesosternal, 4 (5) 3+2 (1); metasternal, 4 (4), 5 (2); on both 2+2 (3/6). Sternal: II, sl lg, sc almost lg to lg, slightly or rather longer than sc, normal (4), 1 and 3 sl + 2 sc (2); III, sl ml to lg, sc sp or (5); VI, 6–8; VII, 7–8; *d*, sh to lg.

FEMALE (2). Count of *allotype* given first, of *paratype* next, if different in the two. II, ant. tc sh. Post. II, 4 tl + 2 tc, 3 or 4+2; III, 2 tl + 2 tc, 2+1 as 1 tc ?; IV, 2 tl + 2 tc; V–VII, 2 tc; VIII, 4 tl + 2 tc, 2+2; IX–XI, ant. and post. sh, both rows asymmetrical; *a*, sh; *b*, sh on edge of tergite. Post-spiracular: as in male, but on VI, ml, and VII ml to lg. Pleural: IV, 4+3, 4+2; V, 4+4, 4+5; VI, 5+4, 4+5; *v*, 2, 4; marginal and submarginal, 9. Meso- and meta-sternal, 2+2. Sternal: II, all lg, 2 sl + 2 sc, 3+2, sl and sc about equal or sl slightly longer; III, all ml, sl and sc about equal; VI, 6, 4; VII, 6, 8; between VII and VIII, 5, 6, ml; *d*, ml. Sp setae on or near margin of vulva, 14, 20; on sub-genital plate, 5–8 sp setae.

MATERIAL EXAMINED.

Holotype ♂, from *Ephippiorhynchus senegalensis* (Shaw), slide no. 708, ZAMBIA: Luangwa Valley, Npika (*W. Büttiker*) BMNH.

Paratypes. 4 ♂, 2 ♀ from the same host-individual (*W. Büttiker*, 657); 1 ♂, SUDAN (*R. Meinertzhagen*, 4807), BMNH.

Table IV. Distance in millimetres between the two tergocentral setae on VIII in males of Ardeicola species.

Species	Range	Mean
lepidus	0.016-0.033	0.023 (3)
signatus	0.033 (1)	
bicolor	0.023-0.049	0.034 (4)
dissourae	0.026-0.039	0.032 (5)
senegalensis	0.095-0.114	0.102 (5)
castaneus	0.059-0.095	0.082 (4)

6. ***Ardeicola castaneus*** (Piaget, 1885)

(Text-figs 10, 19, 53; Tables III, IV)

Probable host: *Dissoura episcopus neglecta* Finsch.

Lipeurus castaneus Piaget, 1885 : 62. Host: *Ciconia leucocephala.*
Degeeriella episcopi Qadri, 1936 : 643, fig. 4. Host: *Dissoura episcopa.*

Lipeurus castaneus was described from *Ciconia leucocephala* = *Dissoura episcopus.* Specimens of *Ardeicola* have been examined from two subspecies of *D. episcopus*, the African *microscelis* and Eastern *episcopus*, and prove to differ specifically. It is necessary therefore to determine which of the two races is the true host of *castaneus*. Dr Theresa Clay has kindly examined the two females (segments II, III of one being damaged) in the British Museum (Nat. Hist.) collections, perhaps the original specimens of Piaget, and finds that there are 4 (2 central + 2 lateral) tergal setae on some abdominal segments, apart from II. The count of tl setae is: III (1), IV (1), V (2), VII (1), 2; IV (1), VI (2), VII (1), ?+1. As 4 (2 tl + 2 tc) setae are not present on segments III-VII in *Ardeicola* from *D. e. microscelis*, this as the host of *castaneus* is ruled out. But 4 tergal setae are present on segments III-VII in *Ardeicola* from *D.e. episcopus*, so that either this or some other Eastern subspecies, probably *neglecta*, is the true host of *castaneus*.

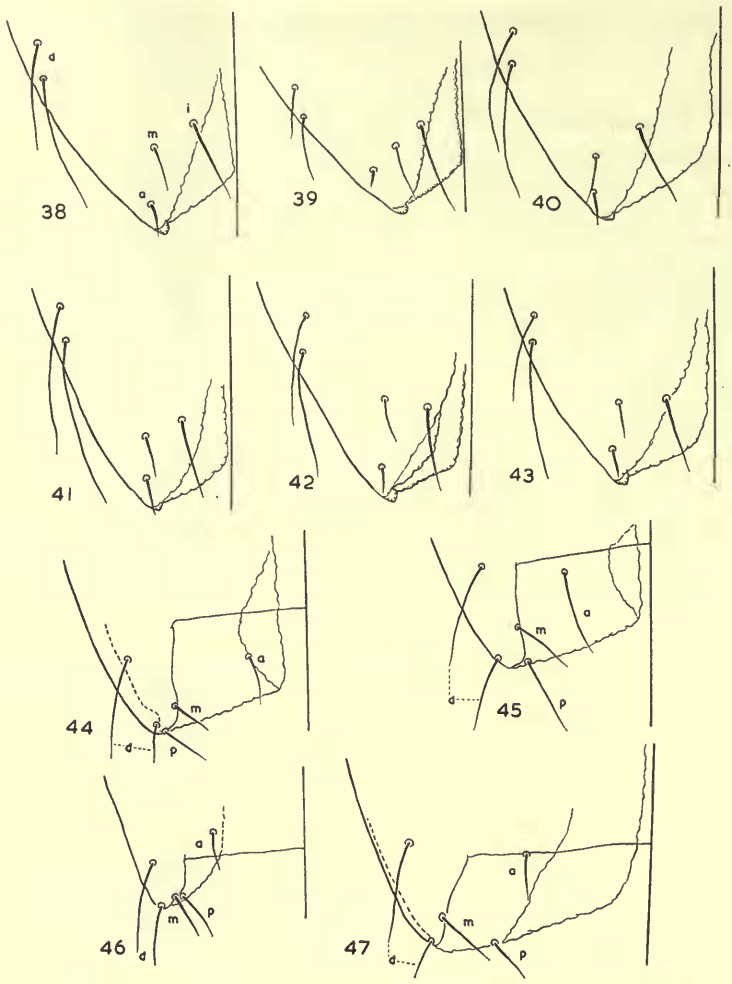
CHAETOTAXY. MALE (8). Inner pronotal ml. Telg setae, 5+4 (1), 4+6 (1), and 1 tsp + 2 ttr + 5+3 telg (1). Tergal: II, ant. tc sh. Post. II (8), III (4), IV (6), V (5), VI (3), VII (5), 2 tl + 2 tc, and in rest on III–VII, 0 or 1 tl + 2 tc as 1 or 2 tl ?; VIII, 2 tl + 2 tc (7), 1+2 (1), the 2 tc setae relatively thin, as in *bicolor*, but wide apart (Table IV); IX–XI, ant. sh, post. ml; *a*, absent (the lateral or dorso-lateral seta near *v* is interpreted as *p* on the basis of its proportions); *b*, ml on or off tergite. Post-spiracular: III, m to sh, 1+1 (only 1/8); IV, sh, 1+1 (4/8); in remaining 7 on III, and in 4 on IV, either 1 or none apparent; V–VIII, 1+1; V, sh; VI, sh to ml; VII, almost ml to lg. Pleural: IV, 2–4, total 4–7, $\bar{x}$ 5·87 (8), 3+3 (4); V, 3–4 total 6–8, $\bar{x}$ 5·62 (8), 3+3 (5); VI, 4+4; *p*, normally sh or ml also, fine; *v*, 2–3 (6), 1+0 (1); marginal and submarginal, 1–3 (total 2–5). Meso- and meta-sternal, 2 (5), 3–4 (3); on both 1+1 (3/8). Sternal. II, almost lg, sl slightly longer than sc, normal (5), 3 sl + 2 sc (1); III, sl ml to lg, sc sh; VI, 6–8; VII, 7–9; *d*, ml to almost lg.

FEMALE (9). Inner pronotal sh. Tergal: II, ant. tc m or sh. Post. II (7), III (7), IV (5), V (6), VI (3), VII (6) 2 tl + 2 tc, and in rest as in male; VIII, 2 tl + 2 tc (8), 1+2 (1); IX–XI, ant. sh and post ml; *a*, 0 (2), 1 (2); *b*, sh slightly removed from edge of tergite, 0+1 (1/9). Post-spiracular: III, sh, 1+1 (only 1/9); IV, sh, 1+1 (5/9); in remaining 8 on III, and in 4 on IV, either 1 or none apparent; V (7), VI (8), sh, 1+1, and respectively in remaining 2 and 1 only 1 apparent; VIII, sh to ml, 1+1. Pleural: III, 1+2 (1/8) IV, 2–4, total 5–8, $\bar{x}$ 6·62(8), 3+3 (2); V, 3+3 (3), 4+4 (5), $\bar{x}$ 7·25 (8); VI, 4+4; VIII, 3+4 (1/8); *v*, 2–3 (5), 0+1 (1); marginal and submarginal, 3–5 (total 7–9). Mesosternal, 2 (5), 3–4 (4); metasternal, 2 (1), 3–4 (6). Sternal: II, sl lg, sc usually lg or sh also, sl slightly or rather longer than sc, normal (3), 3 sl + 2 sc (2), 4+2 (3); III, sl lg, sc sh to ml, normal (6), 4 sl + 2 sc (1); VI, 7–9; VII, 6–8; between VII and VIII, 2–4 sh; *d*, sh to lg. Sp setae on or near margin of vulva, 13–22 (5–9 central, 3–7 (total 8–14) lateral); on sub-genital plate, 4–8 sp setae.

MATERIALS EXAMINED

Piaget's syntypes, 2 ♀ (no locality) from *Ciconia leucocephala* = *Dissoura episcopus neglecta.*

LECTOTYPE ♀ of *Lipeurus castaneus* Piaget, by present designation, slide no. 1088, BMNH.



FIGS 38–47. Anal setae. 38–43, Female: 38, *A. senegalensis* sp. n.; 39, *A. lepidus*; 40, *A. maculatus*; 41, *A. hopkinsi*; 42, *A. hardayali*; 43, *A. ciconiae*. 44–47, Male: 44, *A. ciconiae*; 45, *A. dissourae* sp. n.; 46, *A. hardayali*; 47, *A. fissimaculatus*.

Paralectotype ♀. Mounted on same slide as lectotype, BMNH.

Other material. 8 ♂, 9 ♀, from *Dissoura e. episcopus* (Boddaert), BURMA (*R. Meinertzhagen*, 4811), BMNH.

The four species to follow (7–10), of which the series are below optimal quality, are closely related. Their males can be distinguished from each other by a combination of some or all of the following characters: (1) degree of sclerotization and colour pattern of the dorsum; (2) shape of head and terminalia; (3) proportions of the components of the genitalia, especially the length of the parameres and lower endomere of the mesosome (Table VII); (4) length and/or proportions of setae *a*

and φ; (5) length of post-spiracular setae and anterior tc setae on II and anterior tergals on IX-XI; (6) relative lengths of tc and tl setae on VIII, (7) of sl and sc setae on II and III; (8) number and average of pleural setae on III-VI. Their females are less easily separable by characters 1, 2, 5, 7 and 8.

In these forms other non-sexual characters show slight differences only. As terga II–VII normally have 4 posterior (2 tl + 2 tc) setae, only the deviation thereform has been given in the descriptions. Whether it is real or apparent could not always be determined due to the poor state of the specimens. For the same reason the nature of tergal thickening VIII and proportions of tergal setae on this segment in the male, and the shape of supra-vulval sclerites in the female, could not be determined precisely. A study of these characters in good series is most essential.

7. *Ardeicola maculatus* (Nitzsch, 1866)

(Pl. I, fig. 1; Pl. II, fig. 5; Text-figs 12, 35, 40, 57; Tables V, VII)

Lipeurus maculatus Nitzsch, 1866 : 383. Host: *Ciconia nigra*.
Lipeurus variegatus Neumann, 1912 : 381, figs 27, 28. Host: *Ciconia nigra* and other birds.

Figure 27 in Neumann (1912) is of a nymph, and fig. 28 suggests it to have been a third instar nymph of the species named by him as *Lipeurus variegatus*.

Table V. Measurements in millimetres of Ardeicola species mounted in Canada balsam.

		Male					Female			
		maculatus (6)		keleri (7)			maculatus (4)		keleri (8)	
		Range	Mean	Range	Mean	Holotype	Range	Mean	Range	Mean
Head	L	0.95-1.00	0.97	0.87-0.91	0.89	0.89	1.04-1.07	1.05	0.91-1.01	0.95
	L_1	0.48-0.54	0.52	0.51-0.54	0.52	0.52	0.54-0.58	0.55	0.54-0.59	0.57
	L_2	0.43-0.47	0.45	0.36-0.39	0.37	0.37	0.48-0.51	0.50	0.37-0.42	0.38
	B	0.57-0.61	0.58	0.50-0.55	0.53	0.50	0.61-0.65	0.63	0.57-0.62	0.60
Prothorax	L	0.21-0.24	0.22	0.18-0.21	0.19	0.21	0.22-0.24	0.23	0.19-0.22	0.22
	B	0.46-0.48	0.47	0.36-0.43	0.40	0.36	0.48-0.51	0.50	0.40-0.47	0.44
Pterothorax	L	0.46-0.53	0.50	0.40-0.46	0.43	0.40	0.51-0.55	0.53	0.42-0.50	0.47
	B	0.60-0.64	0.62	0.43-0.64	0.55	0.43	0.59-0.69	0.64	0.57-0.69	0.65
Abdomen	L	2.39-2.60	2.48	1.94-2.19	2.05	2.05	3.22-3.33	3.26	2.78-3.03	2.93
	B	0.71-0.75	0.72	0.57-0.66	0.61	0.58	0.83-0.86	0.84	0.65-0.84	0.75
	T.l.	4.07-4.25	4.16	3.42-3.73	3.58	3.54	5.02-5.19	5.09	4.33-4.73	4.58
	C.I.	0.59-0.62	0.60	0.56-0.62	0.58	0.61	0.57-0.61	0.59	0.59-0.67	0.62

L, length; L_1, length of preantennal region; L_2, length of postantennal region; B, breadth; T.l., total length; C.I., head index.

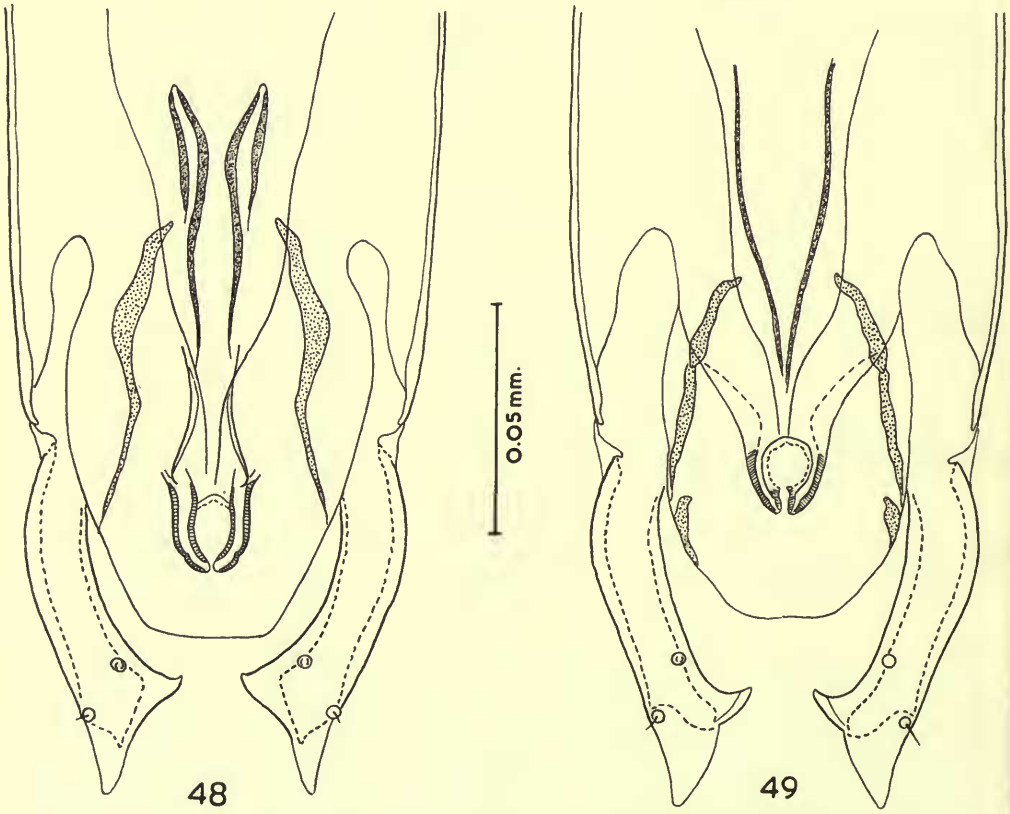
This is a moderately sclerotized species, producing the general affect of light brown. Lateral margins of terga II–VIII characteristically pigmented and merging rather gradually with the general tergal pigmentation. Outlines of lateral tergites III–VIII distinct, unlike the other three related species. In the male no striking, in the female only slight, contrast in the intensity of pigmentation of anterior and posterior portions of terga IX–XI. Male terminal segment rather short and broad, its lateral margins rather straight. Among the closely related species its lower endomere and parameres are the longest (Table VII).

CHAETOTAXY. MALE (6). Inner pronotal almost lg to lg. Telg setae, 5+6 (1). Tergal: II, ant. tc sh. Post. II (1), III (1), VI (1), 1 tl + 2 tc as 1 tl ?; VII, 3 tl + 2 tc (1); VIII, 3 tl + 2 tc (5), 2+2 (1); IX–XI, ant. ml to almost lg, post. broken but alveoli of tl setae asymmetrical (1); *b*, ml to almost lg, well on tergite, 1+2 (1). Post-spiracular: III, IV, ml; V, ml to almost lg; VI, VII, lg.

Anterior submarginal setae on IX–XI, 4–6 (total 8–11). These are similar in proportions, hence not separable into *a* and *p*, but the 2–4 (total 4–7) ventral setae are perhaps *v*.

Pleural: IV, 3–6, total 7–10, $\bar{x}$ 8·16 (6), 4+4 (4); V, 4–7, total 8–13, $\bar{x}$ 10·66 (6); VI, 4–5, total 8–10, $\bar{x}$ 9·16 (6), 4+4 (1); marginal and submarginal, 2–6 (total 5–10). Mesosternal, 2+2 (5), 3 (1); metasternal, 1+1 (5); respectively on these 2+2 and 1+1 (4). Sternal: II, sl lg, sc usually ml or lg also, sl much longer than sc; III, sl lg, sc sh; VI, 6–9; VII, 7–9; VIII, 3 (1/6); *d*, lg.

FEMALE (4). Post. III (1), V (1), 2 tl + 3 tc; VIII, 2 tl + 2 tc (1), 4+2 (1), 5+? (1), ?+2 (1); IX–XI, ant. sh, close to lateral margins of tergite, post. tl sh, tc sh to almost ml; *a*, sh;



FIGS 48, 49. Male genitalia: 48, *A. signatus*; 49, *A. lepidus*.

b, sh, on edge of tergite or near it. Pleural: IV, 5–7, total 10–13, $\bar{x}$ 11·00 (4); V, 4–8 total 9–15, $\bar{x}$ 11·75 (4); VI, 4–7, total 10–13, $\bar{x}$ 11·00, 4+4 in none; VII, 5+5 (1/4); *p*, sh to almost ml; *v*, 2–4 (total 5–7); marginal and submarginal, 4–9 (total 10–15). Meso- and meta-sternal, 2+2 and 1+1 respectively. Sternal: II, sl lg, sc almost lg to lg, sl usually slightly or much longer than sc; III, sl ml to lg, sc sh; VI, 8; VII, 6; between VII and VIII, 3–6 (total 7–10) sh to ml; *d*, lg. Sp setae on or near margin of vulva, 22–29 (8–13 central, 6–10 (total 12–17) lateral); anteriorly in genital region, 9–11 sp setae.

MATERIAL EXAMINED

9 ♂, 8 ♀ from the type-host *Ciconia nigra* (Linnaeus), RUSSIA (*R. Meinertzhagen*, 1768, 1770 c, d and 4816).

NEOTYPE ♂ of *Lipeurus maculatus* Nitzsch, by present designation, from *Ciconia nigra*, slide no. 1768a, RUSSIA: Caucasus, xi. 1903 (*R. Meinertzhagen*), BMNH.

Neoparatypes 8 ♂, 8 ♀ from the type-host, RUSSIA: various localities.

8. ***Ardeicola tantali*** (J. C. Fabricius, 1798)

(Pl. I, fig. 2; Pl. II, fig. 6; Text-figs 34, 54, 58; Tables VI, VII)

Pediculus tantali J. C. Fabricius, 1798 : 571. Host: *Tantalus leucocephalus*.

This Fabrician species has been dealt with by Clay & Hopkins (1960: 10), who examined the syntypes and designated a male as the lectotype (l.c., p. 6, figs 3, 4).

This species is close to *maculatus* and *asiaticus*. Feebly to moderately sclerotized, producing the general affect of light brown. Outer margins of terga II–VIII brown, and in their colour intensity and that of the rest of the thickening there is strong contrast. Male terminal segment rather long and narrow and its lateral margins slightly curved. Colour pattern of terga IX–XI as in *maculatus*.

CHAETOTAXY. Length of many setae as in *maculatus*. MALE (10). Telg setae, 4+5 (2). Tergal: II, ant. tc sh to almost ml. Post. II (1), III (1), 2 tl + ? tc; VI, 2+3 (1), 3+2/(1); VIII, 2 tl + 2 tc (2), 2+? (1), 3 or 4+2 (3), 2 or 3+3 (2); IX–XI, post. ml, 2 tl + 3 tc (1), tc and tl equal or tc slightly longer; *a*, lg, 1+0 or 0+1 (3), 0 (2); *b*, ml to lg, apparently on tergite, 1+2 (1). Post-spiracular: VII, 1+2 (1); III–V, ml; VI, VII, usually lg or ml also. Pleural: III, ?+1 (1); IV, 3–5, total 7–9, $\bar{x}$ 7·80 (10), 4+4 (6); V, 4–6, total 9–11, $\bar{x}$ 9·80 (10); VI, 3–6, total 8–11, $\bar{x}$ 9·62 (8); VII, 4+5 (1/9); VIII, 3+4 (1); *p*, usually ml to almost lg or sh also, slightly shorter and finer than *a*, and 1+0 (1/9); *v*, 2–4 (total 4–8); marginal and submarginal, 2–3 (total 5–6). Mesosternal, 2–3 (2), 4 (6), 5 (1); metasternal, 1+1. Sternal: II, sl lg, sc usually ml to lg or sh also, sl much longer than sc; III, sl lg, sc sh; VI, 7–9; VII, 8–9; *d*, ml.

FEMALE (9). Inner pronotal ml to lg. Telg setae, 4+5 (1), 5+4 (1). Tergal: II, ant. tc sh. Post. VIII, 2 tl + 2 tc (2), 3+2 (3), 4+2 (3), 3+3 (1); IX–XI, ant. and post. sh, tc very slightly longer than tl; *a*, sh, 0+1 (1/9); *b*, sh near edge of tergite. Post-spiracular: III, ? or 1+? (2); IV, ?+1 (1); III, IV, ml; V–VII, ml to almost lg. Pleural: IV, 3–5, total 7–10, $\bar{x}$ 8·44 (9), 4+4 (6); V, 4–7, total 9–13, $\bar{x}$ 11·00 (9); VI, 4–6, total 9–12, $\bar{x}$ 10·30 (8); VII, 3–5, total 7–9, $\bar{x}$ 8·22 (9); VIII, 5+4 (1/9), 4+1 (1/9); *p*, sh or ml; *v*, 3–5; marginal and submarginal, 4–6 (total 9–11). Mesosternal, 2 (2), 4 (6); metasternal, 2 (7); respectively on these 2+2 and 1+1 (5). Sternal: II, III, as in male; VI, 6–8; VII, 6–7; between VII and VIII, 2–5 (total 4–9) sh to ml; *d*, ml to lg. Sp setae on or near margin of vulva, 13–23 (4–8 central, 4–8 (total 9–16) lateral); anteriorly in genital region, 3–5 sp setae.

MATERIAL EXAMINED.

From the type-host, *Ibis leucocephalus* (Pennant). Homotypes 4 ♂, 13 ♀, INDIA: Rajputana, iii. 1937 (*R. Meinertzhagen*, 8885). 4 ♂ (dissected) with exactly same data. 4 ♂, 7 ♀, INDIA (*R. Meinertzhagen*, 4817) and 3 ♂ (2 dissected), 1 ♀, INDIA: Lucknow (*B. K. Tandan*), BMNH.

Table VI. Measurements in millimetres of Ardeicola species mounted in Canada balsam.

		Male					Female			
		tantali (12)		asiaticus			tantali (9)		asiaticus (4)	
		Range	Mean	Holotype	Paratype	Mean	Range	Mean	Range	Mean
Head	L	0.84-0.95	0.90	0.89	0.90	0.895	0.95-1.01	0.97	1.00-1.01	1.00
	L_1	0.45-0.54	0.50	0.48	0.53	0.505	0.53-0.57	0.54	0.57-0.59	0.58
	L_2	0.39-0.41	0.40	0.41	0.37	0.390	0.41-0.44	0.43	0.40-0.44	0.42
	B	0.50-0.55	0.53	0.55	0.54	0.545	0.55-0.62	0.58	0.61-0.68	0.64
Prothorax	L	0.17-0.22	0.19	0.20	0.18	0.190	0.18-0.22	0.20	0.19-0.22	0.21
	B	0.40-0.49	0.44	0.43	0.44	0.435	0.42-0.47	0.44	0.47-0.53	0.50
Pterothorax	L	0.37-0.44	0.42	0.43	0.41	0.420	0.42-0.47	0.44	0.43-0.48	0.46
	B	0.50-0.65	0.54	0.54	0.55	0.545	0.55-0.62	0.60	0.59-0.68	0.64
Abdomen	L	2.06-2.24	2.13	2.07	2.06	2.065	2.64-2.95	2.81	2.82-3.04	2.93
	B	0.58-0.69	0.64	0.65	0.68	0.665	0.72-0.82	0.76	0.73-0.91	0.83
	T.1.	3.49-3.82	3.64	3.60	3.55	3.575	4.20-4.63	4.41	4.45-4.59	4.53
	C.I.	0.55-0.63	0.59	0.62	0.60	0.610	0.59-0.64	0.61	0.61-0.66	0.63

L, length; L_1, length of preantennal region; L_2, length of postantennal region; B, breadth; T.1., total length; C.I., head index.

9. *Ardeicola asiaticus* sp. n.

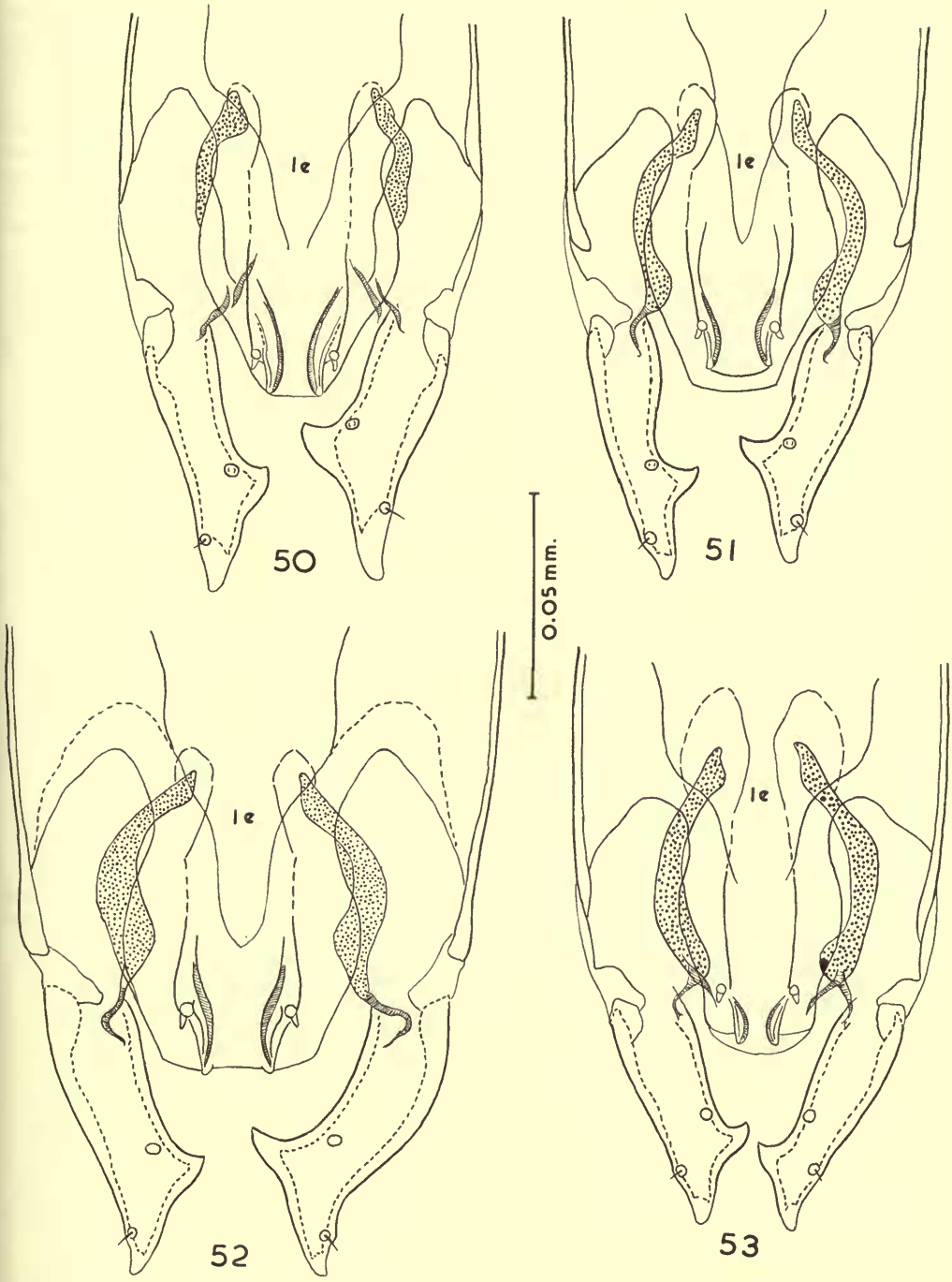
(Pl. I, fig. 3; Pl. II, fig. 7; Text-figs 37, 55; Tables VI, VII)

Type-host: *Xenorhynchus a. asiaticus* (Latham)

This species is closest to *tantali*[1] and its male can be distinguished by its smaller size and by characters 3 and 4 given on page 142, but the females are difficult to separate.

CHAETOTAXY. MALE (2). Inner pronotal broken. Telg setae, 4+5 (1). Tergal: II, ant. tc sh, rather fine. Post. VIII, 3 tl + 2 tc (?), 4+3 (?); IX–XI, ant. ml relatively more lateral, post. broken; *a*, lg on tergite or near its edge; *b*, lg on tergite. Post-spiracular: III, almost lg; IV, broken; V, almost lg to lg; VI, VII, lg. Pleural: IV, 3+3, 5+5, $\bar{x}$ 8·00; V, 5+4, 6+5, $\bar{x}$ 10·00; VI, 5+5, 6+6, $\bar{x}$ 11·00; VII, 5+4, 5+5, $\bar{x}$ 9·50; *p*, ml to almost lg, translucent, stouter

[1] Examination of the single male type of *A. porrectus* (Piaget, 1890), described from *Buceros bicornis*, shows it to be closest to *asiaticus* and *tantali*. Its true host, however, cannot be ascertained until *Ardeicola* from other Eastern Ciconiidae are available.



FIGS 50–53. Male genitalia: 50, *A. dissourae* sp. n.; 51, *A. bicolor*; 52, *A. senegalensis* sp. n.; 53, *A. castaneus*; (le, lower endomere).

than in *keleri*; *v*, 1–2 (total 2–4); marginal and submarginal, 4+4, 5+4, broken. Meso- and meta-sternal, 3, 5, and 2, 4 respectively. Sternal: II, sl lg, sc ml to lg, sl much longer than sc; III, sl ml to lg, sc sh, between sl and sc 1+0 ml also (1); VI, 7, 11; VII, 8, 11; VIII, 3 (1); *d*, ml to lg.

Female (4). Inner pronotal ml to lg. Telg setae, 5+4 (1). Tergal: Post. II (1), III (2), IV (2), V–VII (1), 2 tl + 3 tc; VII, 2 tl + 4 tc (1); VIII, 4 tl + 4 tc (3), 3+? (1); IX–XI, ant. sh, post. tc sh to ml, tl sh, 2 tl + 3 tc (2); *a*, ?+1 or ? (2), sh; *b*, sh off tergite or on its edge. Post-spiracular: as in male but on III, 1+? (2), on III, ml also and on IV, ml to lg. Pleural: III, 0+1 (1); IV, 4+6, total 8–11, $\bar{x}$ 9·25 (4); V, 5–8, total 12–15, $\bar{x}$ 13·00 (4); VI, 5–8, total 10–16, $\bar{x}$ 13·00 (4); VII, 4–7, total 9–15, $\bar{x}$ 10·25 (4), no specimen with 4+4; VIII, 5+5 (1); *p*, sh to almost ml; *v*, 2–4 (total 4–7); marginal and submarginal, 4–6 (total 9–11). Mesosternal, 4–7; metasternal, 2 (2), 4 (1); respectively on these 2+2 and 1+1 (1). Sternal: II, as in male; III, sl lg, sc sh to almost ml, 2 sl + 4 sc (1); VI, 4+4; VII, 5–7; between VII and VIII, 4–6 (total 8–11) sh to ml; *d*, ml to lg. Sp setae on or near margin of vulva, 18–25 (5–7 central, 6–9 (total 13–18) lateral); anteriorly in genital region 2–4 m setae.

Material examined

Holotype ♂ from *Xenorhynchus a. asiaticus* (Latham), slide no. 4806 a, India (*R. Meinertzhagen*), BMNH.

Paratypes 1 ♂, 7 ♀, from the type-host, India: Rajputana (*R. Meinertzhagen*, 4806, 9045, 9080), BMNH.

10. *Ardeicola keleri* sp. n.

(Pl. I, fig. 4; Pl. II, fig. 8; Text-figs 36, 56, 59; Tables V, VII)

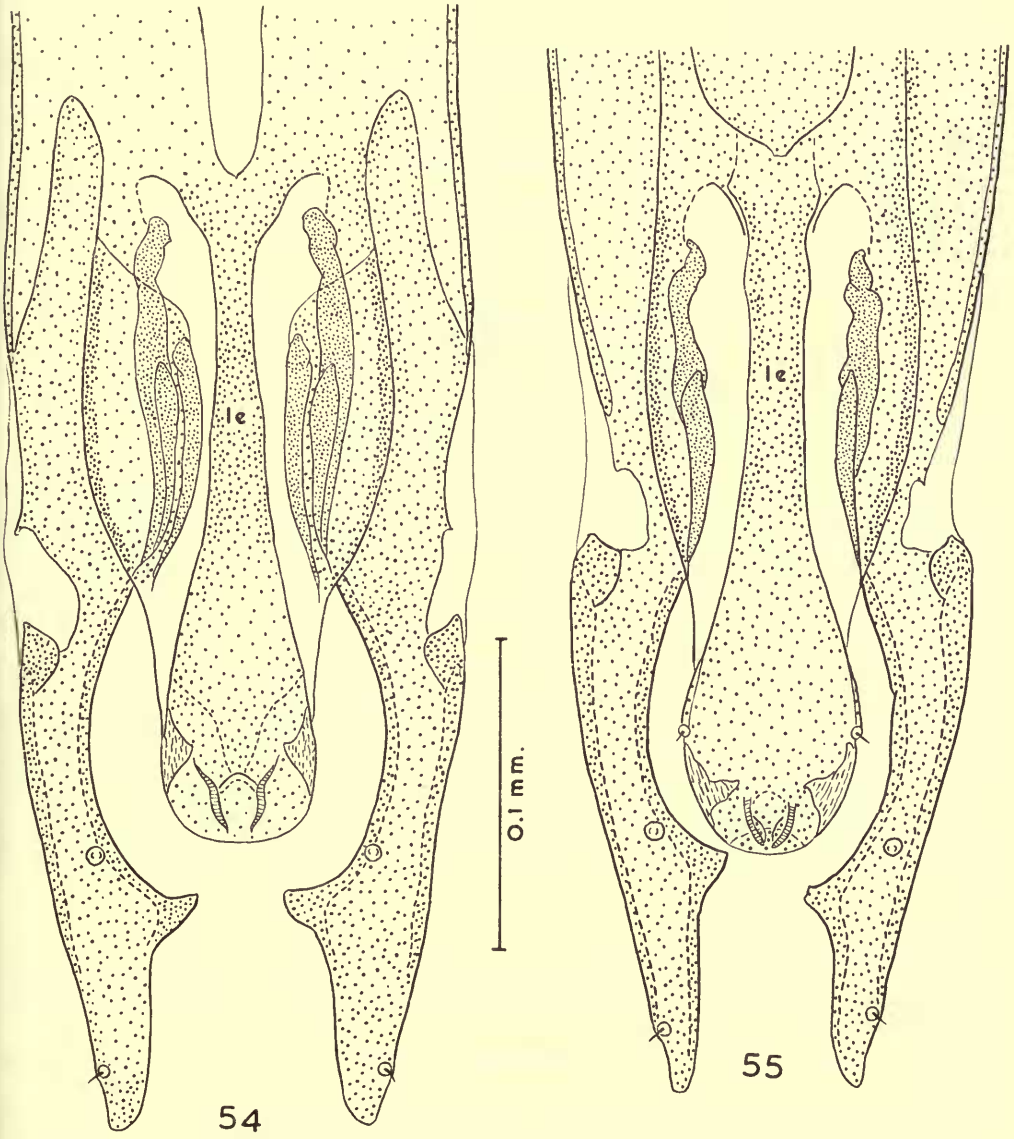
Type-host: *Ibis ibis* (Linnaeus).

Of the four related species, *maculatus* et al., this is the most distinctive and its male is the smallest (Text-fig. 1). Feebly sclerotized, straw-coloured. Outer margins of tergum II unpigmented; in male those of III–VI or VII are dark brown, but the pigmented area is the smallest among related taxa; in the female outer margins of terga III–VIII are dark to chestnut-brown and the pigmented area is distinctive and diagnostic. In both the sezes terga IX–XI are well pigmented and much darker posteriorly. The colour pattern, even of tergum III alone, separates this species readily from related ones. Male terminal segment short and wide and its lateral margins slightly to rather curved; setae in genital region shorter and finer. Tendeiro (1958) has given figures of the male head and genitalia of this species.

Table VII. Length in millimetres of components of male genitalia of Ardeicola species.

		maculatus	asiaticus	tantali	keleri
Basal apodeme	Range	0.93-1.10	1.00	0.77-1.11	0.59-0.77
	Mean	0.99 (6)	1.00 (1)	0.99 (9)	0.69 (7)
Mesosome (lower endomere)	Range	0.227-0.249	0.206	0.183-0.196	0.136-0.152
	Mean	0.240 (6)	0.206 (1)	0.193 (11)	0.145 (4)
Paramere	Range	0.171-0.183	0.152-0.157	0.137-0.170	0.124-0.136
	Mean	0.179 (8)	0.154 (2)	0.153 (22)	0.131 (12)

CHAETOTAXY. MALE (7). Inner pronotal ml to almost lg. Telg setae, 4+4 (2). Tergal: II, ant. tc sh. Post. VIII, 2 tl + 2 tc (5), 3+4 (1), 2+? (1); IX–XI, ant. ml, 0+1 (1), post. sh to ml, tc and tl equal or tc slightly longer; *a*, lg on or off tergite, 0+0 or 1 (3); *b*, ml to lg well on tergite. Post-spiracular: III, 1+? (1); VI, 2+1 (1); VII, 1+2 (1); III–V, ml; VI, ml to almost lg; VII, almost lg. Pleural: IV, 3–6, total 7–11, $\bar{x}$ 8·14 (7), 4+4 (4); V, 4–6, total 8–10, $\bar{x}$ 9·28 (7); VI, VII, 4–5, total 8–9, $\bar{x}$ 8·14 (7), 4+4 (6); *p*, sh to ml fine, translucent; *v*, 1–3 (total 3–5); marginal and submarginal, 1–4. Mesosternal, 3–5; metasternal, 1+1. Sternal: II, sl lg, sc usually ml or lg also, sl much longer than sc; III, sl ml to lg, sc usually sh or ml also; VI, 7–8; VII, 6–8; *d*, lg.



FIGS 54, 55. Male genitalia: 54, *A. tantali*; 55, *A. asiaticus* sp. n. (le, lower endomere).

Female (8). Inner pronotal ml. Telg setae, 4+5 or 5+4 (2). Tergal: VIII, 2 tl + 2 tc (4), 3+2 (2), 3 or 4+? (2); IX–XI, ant. and post. sh; *a*, 0+1 (2), near edge of or well on tergite; *b*, sh and as *a*. Post-spiracular: III, 1+? (1); III, ml; IV, V, ml to almost lg; VI, VII, ml to to lg. Pleural: III, 1+2 (1); IV, 4–7, total 9–13, $\bar{x}$ 10·00 (8); V, as on IV, but $\bar{x}$ 11·12; VI, 4–6, total 8–12, $\bar{x}$ 9·75 (8), 4+4 (3); VII, 5+4 (2); *v*, 1–3 (total 3–6); marginal and submarginal, 5–7 (total 10–13). Meso-sternal, 4 (6), 5 (2); metasternal, 1+1. Sternal: II, sl lg, sc usually ml to almost lg or sh also, sl much longer than sc; III, sl usually ml or sh also, sc sh, sl slightly longer than sc, 2 sl + 3 sc (2), and 1+2 (2) as 1 sl ?; VI, 7–8; VII, 6; between VII and VIII, 1–3 (total 3–6) sh to ml; *d*, ml to lg. Sp setae on or near margin or vulva, 16–20 (5–7 central, 3–8 (total 11–14) lateral); anteriorly in genital region, 4–8 sp setae.

Material examined

Holotype ♂, from *Ibis ibis* (Linnaeus), slide no. 710, Kenya: Limuru, 6.i.1937 (*G. H. E. Hopkins*), BMNH.

Paratypes. 2 ♂, 3 ♀ from the same host individual; 4 ♂, 5 ♀ from another bird, Kenya: iii.1945 (*R. Meinertzhagen*, 18865), BMNH.

This species is dedicated to Dr. Stefan von Kéler, the eminent authority on Mallophaga, who died in 1968.

11. *Ardeicola loculator* (Giebel, 1874)

(Text-figs 8, 17, 20, 25; Table I)

Lipeurus loculator Giebel, 1874 : 228. Host: *Tantalus loculator*.
Lipeurus linearis Rudow, 1869 (nec *L. linearis* Nitzsch, 1866): 35.

This is the only species of the *ciconiae* species-group having only 1+1 inner, posterior, prothoracic setae (Text-fig. 8), a character which readily separates it from all other species. Other distinguishing characters are, the well developed temporal carinae in the male (fig. 10 in Kumar & Tandan, 1968) and the dark lateral spots on the occiput and anteriorly on tergal thickening V–VIII in the female (Text-figs 8, 17).

Male heavily, female moderately, sclerotized; gular plate weakly so in both sexes, hence it is less evident in the male.

Chaetotaxy. Male (13). See Kumar & Tandan (1968). Seta *b*, lg well on tergite or near its edge; *p*, ml to lg. Meso- and meta-sternal, 1+1. Seta *d*, ml to lg.

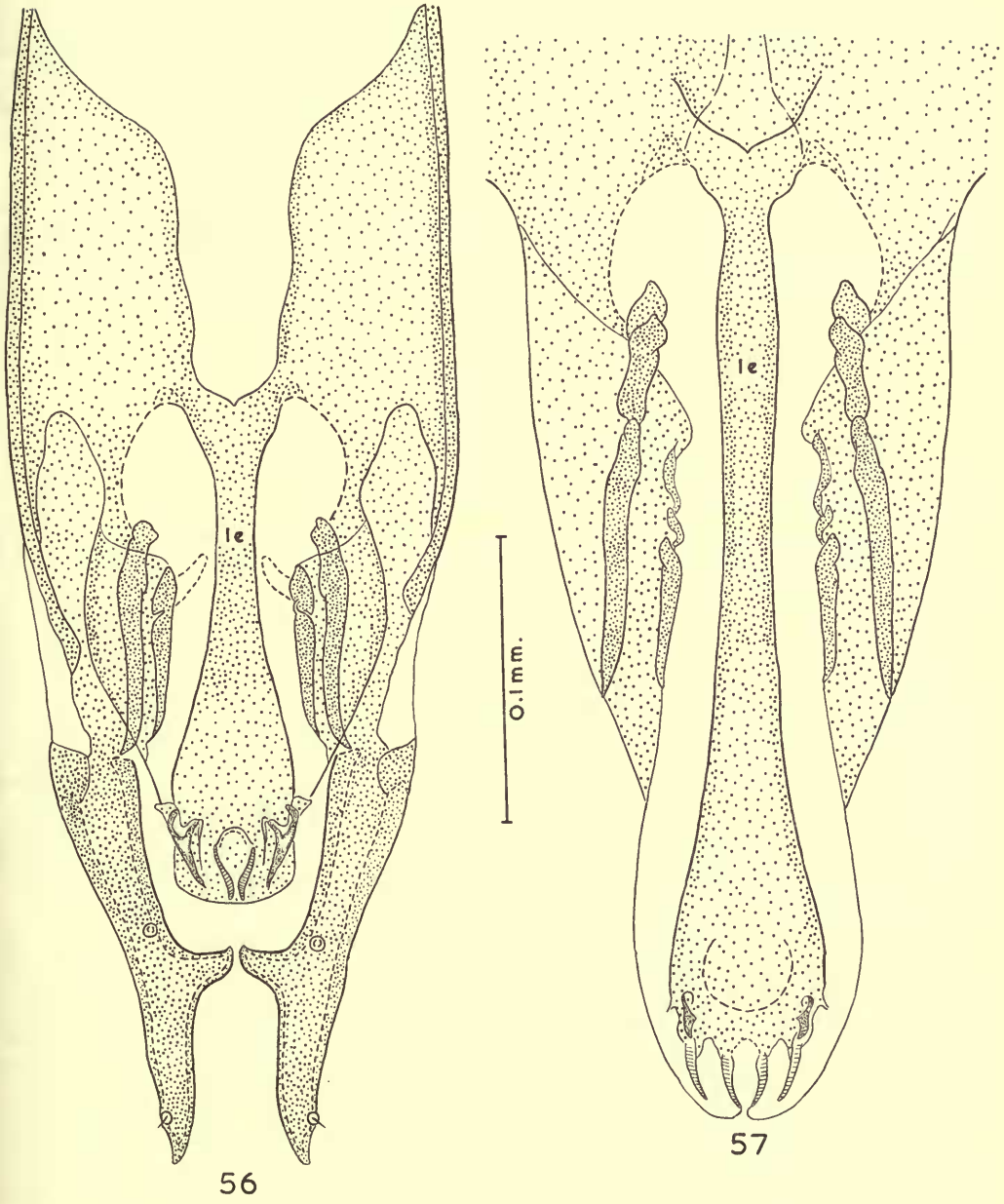
Female (2). Tergal: II–VIII, as in male; IX–XI, ant. sh, relatively outer and close to lateral margins of tergite, and post. tl sh, tc sh to ml; *b*, sh or sp off tergite. Post-spiracular: III, ml; IV–VII, lg. Pleural: as in male, but on VIII, 4+3 (1); *v*, 2+2, 3+1; m and sm, 4+5, 4+3. Meso- and meta-sternal, 1+1. Sternal: II–V, as in male, but on IV, 1 sl lg + 2 sc m (1); VI, 8; VII, 6; between VII and VIII, 4–7 sh to ml; *d*, lg. Sp setae on or near margin of vulva, 15–19 (4–5 central, 5–7 (total 11–14) lateral); on sub-genital plate, 2–3 sp setae.

Material examined.

NEOTYPE ♂ of *Lipeurus loculator* Giebel, by present designation, slide no. 4810a, from the type-host, *Mycteria americana* Linnaeus, Mexico (*R. Meinertzhagen*), BMNH.

Neoparatypes. Same data as neotype and U.S.A.: Arizona, Florida, 22 ♂, 1 ♀, BMNH.

Other material. From the type-host, Mexico: Tlacotalpan, 2 ♂, 2 ♀, 22.vi.1961 (*D. H. Jancen*), available through courtesy of Dr. D. W. Tuff.



FIGS 56, 57. Male genitalia: 56, *A. keleri* sp. n.; 57, *A. maculatus* (le, lower endomere).

12. *Ardeicola leucosoma* Kumar & Tandan

Ardeicola leucosoma Kumar & Tandan, 1968 : 266, figs 7–9, 12–14. Host: *Mycteria americana*.

Drs K. C. Emerson and D. W. Tuff think that *M. americana* is perhaps not the true host of *leucosoma*. Sinec the native and scientific name of *Jabiru mycteria*, also found in Guyana, and *M. americana* are rather similar, confusion might have been caused, especially as the skin was not preserved. The question of the true host of *leucosoma* must therefore await until *Ardeicola* from *J. mycteria* also is available.

This species is distinguished from others of the *ciconiae* species group by the following combination of characters: the weakly sclerotized general habitus, 2+2 posterior pronotal setae, 1+1 pleural setae on segment IV in the male, the posterior components of the male genitalia, and the colour pattern of the female abdomen, especially the lateral, faintly pigmented spots on tergal thickening V or VI–VII.

Chaetotaxy. Male. Pleural: V, 1–4, total 2–7, $\bar{x}$ 5·28 (7). Both sexes. Sternal: V, 0–2 sc m or sh.

13. *Ardeicola ciconiae* (Linnaeus, 1758)

(Text-figs 21, 26, 28, 31, 32, 43, 44)

Pediculus ciconiae Linnaeus, 1758 : 613. Host: *Ardea ciconia*.

This species has been treated by Clay & Hopkins (1950 : 252), who also designated neotypes.

A striking feature of *ciconiae* is the extreme variation in the number of telg (pteronotal) setae (Text-figs 29, 30). Out of 55 males and 51 females examined, only in 7 of each sex was the count normal for the species group (5+5). In the rest it varies thus: male, 4+4 (31), 5+4 or 4+5 (17); female, 3+4 (2), 4+4 (24), 5+4 or 4+5 (18). The neotype male, however, has 5+5 telg setae, while the neallotype female has 4+4 setae. This variation is a clear indication that the species is in the act of changing the number of telg setae, but whether 1+1 setae are being lost or added is not clear. In view of the fact that 4+4 is the normal count of telg setae in *Ardeicola* from Threskiornithidae, the presence of 4+4 setae in a large percentage of individuals of both sexes of this species is worthy of note. Equally striking is the variation in the number of posterior tergal setae on segments V and VI. From these variations, especially in the number of pteronotal setae which is an important group character, it is inferred that in the evolutionary scale *ciconiae* is at a different level than other species of the group.

Chaetotaxy. Male. Inner pronotal ml to lg. Telg setae, see above. Tergal (7): II, ant. tc ml to lg. Post. II, VII (6), III, IV, VI (4), V (3), 2 tl + 2 tc; III, 2+1 (1); III, IV, VII (1), VI (2), 1+2; II, 1 tl + 2 tc (1) as 1 tl?; III, 2+1 (1); VI, 1 tl + 1 tc (1) as setae short?; III (1), IV (2), V (4), 2 tc; VIII, 2 tl + 2 tc (6), 3+2 (1), tl on tergite close to posterior margin; IX–XI, ant. sh to ml and post. tl ml to lg, tc lg to elg; *a*, 1+0 (2/6); *b*, lg on tergite. Postspiracular; III, sh; IV, ml; V, ml to almost lg; VI, VII, lg; alveoli of those on IV and VII on tergite. Pleural: IV, 1+1, an important character; V, 2–3, total 4–5, $\bar{x}$ 4·42 (7); VI, 3–4, total 6–7, $\bar{x}$ 6·42 (7); VII, 3+3 (2), 4+3 (1); VIII, 4+3 or 3+4 (2); *p*, sh to lg; *v*, 1–3 (total 3–5); marginal and submarginal, 3–5 (total 6–8). Mesosternal, 2 (8), 3–4 (6); metasternal, 4 (8), 5 (3), 6–7 (3). Sternal: II, all lg, sl and sc equal or sl longer, normal (5), 2 sl (1) as 2 sc ?; III, sl ml, sc lg, normal (2), 0–1 sl + 2 sc (5) as 1 or 2 sl?; V, normal (3), 2 sl + 2 sc (2), 4+2 (1), 2+1 (1), sl sh; on IV, V sc usually ml to lg; VI, 7–11; VII, 8–10; *d*, sh to lg.

Female. Telg setae, see above. Tergal (4): II, ant. tc almost to lg. Post. II, IV (3), III, VII (4), V, VI (1), 2 tl + 2 tc; II, 4 tl + 2 tc (1); IV, V (1), VI (2), 1+2; V (2), VI (1), 2 tc; VIII, 2 tl + 2 tc (3), 3+2 (1); IX–XI, ant. sh, relatively outer and close to lateral margins of

tergite, post. tl sh, tc ml; *a*, *b*, sp or sh, near edge, *a*, away also, of tergite. Post-spiracular: as in male, but on IV sh, on V sh to ml, on VI, VII ml. Pleural: III, 1+2 (1); IV, 1+1, an important character; V, 2–3, total 4–6, $\bar{x}$ 5·25 (4), 3+3 (2); VI, 3–4, total 7–8, $\bar{x}$ 7·50 (4), 4+4 (2): *v*, 1–3 (total 3–5); marginal and submarginal, 4–6 (total 9–12). Mesosternal, 2 (4), 3 (7), 4 (1); metasternal, 4 (7), 5 (4), 6 (1). Sternal: II, 3–6 all lg, 2 sc slightly longer or shorter than others; III, 3–4 sh to lg; on II, III 2 are always sc and rest outer to these; IV, V, sc 2–3 and 2–5 respectively; IV, 6–10; VII, 6–9; between VII and VIII, 2–8 sh; *d*, lg. Sp setae on or near margin of vulva, 19–22 (6–9 central, 5–7 (total 10–14) lateral); on sub-genital plate, 4 or more m setae.

MATERIAL EXAMINED.

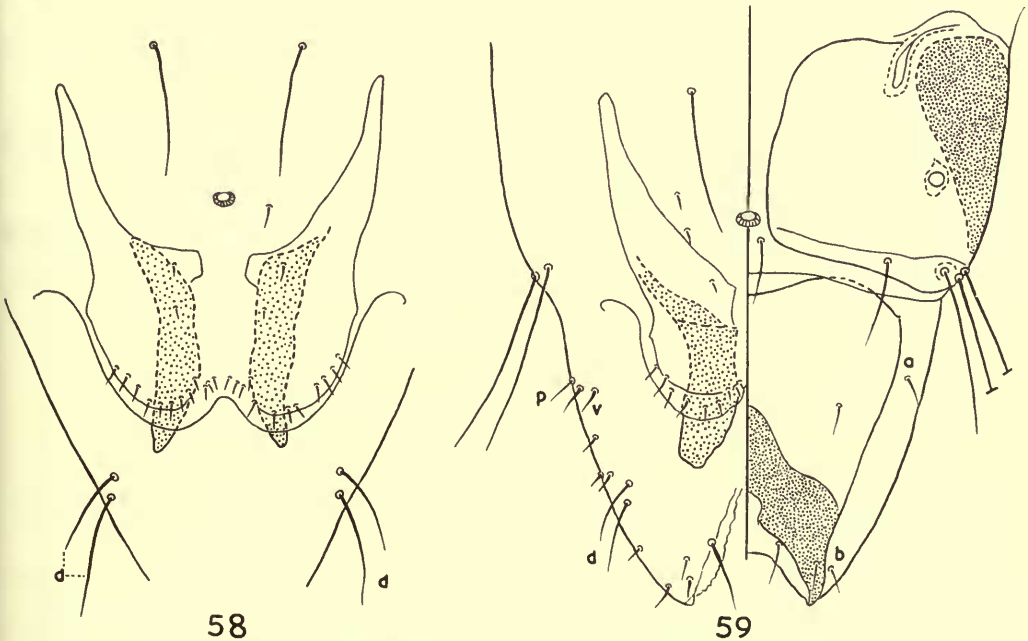
From the type-host, *Ciconia c. ciconia* (Linnaeus). 15 ♂, 12 ♀, KENYA and SUDAN (*R. Meinertzhagen*, 6962, 7857, 14820, 20514). Of these 5 ♂ and 2 ♀ (*R. Meinertzhagen*, 6962, 7857) were neoparatypes and 1 ♂, 1 ♀ neotype and neallotype respectively, BMNH.

14. ***Ardeicola hopkinsi*** Kumar & Tandan, 1968
(Text-fig. 41)

Ardeicola hopkinsi Kumar & Tandan, 1968 : 263, figs 1–6. Host: *Euxeneura galeata*.

Some characters by which this species is distinguished from *ciconiae* are given below.

MALE. Temporal carina not apparent. Post-spiracular setae apparently absent on III Medially anterior margin of tergite V rather, of VI slightly, emarginate, and of VII and VIII very slightly depressed (figs 1, 5 in Tandan & Kumar, 1968). Posterior margin of tergal



FIGS 58, 59. Female terminalia: 58, *A. tantali*; 59, *A. keleri* sp. n.

thickening V–VIII rather curved. Anterior margin of tergite IX–XI slightly curved, and anterior tergal setae thereon lg. Number of marginal and submarginal setae greater. On III–V, 2 sl lg and 2 sc m. In the genitalia the basal apodeme shorter and broader and its articulation with the parameres distinct.

FEMALE. Post-spiracular setae on IV–VII longer. On IX–XI anterior tergal setae not so close to margins of tergite, and posterior tl setae sh and tc setae almost long.

The following two species (15 and 16) are closely related, and are distinguished from the foregoing species by the presence of post-spiracular setae on tergum II. Their distinguishing characters from each other are given elsewhere (Tandan & Kumar, 1969).

15. *Ardeicola fissomaculatus* (Giebel, 1874)

(Text-figs 23, 24, 47)

Lipeurus fissomaculatus Giebel, 1874 : 225. Host: *Mycteria crumenifera.*
Lipeurus genitalis Piaget, 1885 : 58, pl. 6, fig. 5. Host: *Leptoptilos crumeniferus.*

CHAETOTAXY. MALE. Telg setae, 5+4 or 4+5 (2/5). Post-spiracular on II, 0+1 (1/9). Pleural: IV, $\bar{x}$ 3·80 (5); V, $\bar{x}$ 7·00 (5); VI, $\bar{x}$ 8·00 (5). Mesosternal, 2+2 (4); metasternal, 2 (1), 5 (1), 2+2 (2); on both 2+2 (2).

FEMALE. Telg setae, 5+4 (1/3). Pleural: III, 1+2 (1/4); IV, $\bar{x}$ 5·22 (4); V, $\bar{x}$ 7·00 (4); VI, $\bar{x}$ 8·00 (4). Mesosternal, 4 (3), 2 (1): metasternal, 4 (1), 3 and 5 (2); on both 2+2 (1).

MATERIAL EXAMINED.

Syntypes of *Lipeurus genitalis* Piaget, from *Leptoptilos crumeniferus.*

LECTOTYPE ♂ of *Lipeurus genitalis* Piaget, by present designation, slide no. 823, BMNH.

Paralectotypes. 1 ♂, 1 ♀, slides no. 823, 429, BMNH.

Neoparatypes of *Lipeurus* (=*Ardeicola*) *fissomaculatus* Giebel, 1874, designated by G. H. E. Hopkins, 1941 (see also Tandan & Kumar, 1969 : 150), 9 ♂, 11 ♀, UGANDA: Bombo, Buganda, 8.iii.1934 (*G. H. E. Hopkins*), BMNH.

Other material. 5 ♂ (dissected), 4 ♀, from the type-host, *Leptoptilos crumeniferus* (Lesson), SOMALILAND: ii.1949 and KENYA: i.1956 (*R. Meinertzhagen*, 18643, 20535), BMNH.

16. *Ardeicola hardayali* Tandan & Kumar, 1969

(Text-figs 42, 46)

Ardeicola hardayali Tandan & Kumar, 1969 : 145, figs 1, 2, 4, 6, 7, 9, 11–16, 20, 22. Host: *Leptoptilos javanicus.*

CHAETOTAXY. MALE. Telg setae, 5+4 (2/10). Pleural: average of 10. IV, 4·10; V, 5·80; VI, 7·60. Mesosternal, 4 (5), 3 (3), 2 (1); metasternal, 4 (6), 3 (4); on both 2+2 (3).

FEMALE. Telg setae, 4+4 (1/8). Pleural: IV, $\bar{x}$ 4·41 (12); V, $\bar{x}$ 6·27 (11); VI, $\bar{x}$ 7·81 (11). Mesosternal, 4 (6), 3 (4); metasternal, 4 (7), 5 (2), 6 (1); on both 2+2 (5).

Artificial Key to the Species of the *CICONIAE* group

In order to have a key common to both the sexes, non-sexual characters have been employed more than sexual characters. As identification through one character is not always conclusive, more characters, arranged in order of their importance, are given. Numbers in some of the couplets refer to notes given after the key. *A. praelongus* (Piaget, 1880) has been omitted from the key as no material from the Type host, *Ibis cinereus* (Raffles), is available.

1		Post-spiracular setae present on terga II–VII (fig. 6 in Tandan & Kumar, 1969)[1]	2
–		Post-spiracular setae present on terga III–VII (Text-figs 17, 18)[1,2,3]	3
2	(1)	Length over 5·00 mm (Text-fig. 1); terminalia as in figs 3, 5, 8, 10 and male genitalia as in figs 21, 23, in Tandan & Kumar (1969); in male 4–6 sternal setae on VIII (Ethiopian) ***fissomaculatus*** (p. 154)	
–		Length under 4·70 mm (Text-fig. 1); terminalia as in figs 2, 4, 7, 9 and male genitalia as in figs 20, 22, in Tandan & Kumar (1969); in male 2 sternal setae on VIII (Oriental) ***hardayali*** (p. 154)	
3	(1)	Only 2 central setae on terga II–VII (Text-figs 13, 16)	4
–		Normally 4 (2 tl + 2 tc) setae on either tergum II (Text-figs 14, 18) or terga II–IV (Text-fig. 15)[4] or II–VII (Text-figs 17, 19)[5]	5
4	(3)	Body larger, head wider (Text-fig. 4); male genitalia as in Text-fig. 49; basal apodeme with a distinct waist (Text-fig. 32); 14–15 setae on margin of vulva (Oriental) ***lepidus*** (p. 133)	
–		Body smaller, head narrower (Text-fig. 5); male genitalia as in Text-fig. 48; sides of basal apodeme rather straight (Text-fig. 31); 19 or more setae on margin of vulva (Ethiopian). ***signatus*** (p. 134)	
5	(3)	Only on tergum II normally 4 (2 tl + 2 tc) setae (Text-figs 14, 18); on terga III–VII normally 2 tc setae only	6
–		On terga II–IV (Text-fig. 15) or II–VII (Text-figs 17, 19) normally 4 (2 tl + 2 tc) setae[4,5]	7
6	(5)	On tergum III only 2 tc setae (Text-fig. 18); in male tc setae on VIII thicker and longer (Text-fig. 9); female genital opening wide and straight (Ethiopian) ***dissourae*** sp. n. (p. 136)	
–		On tergum III 0–1 tl + 2 tc setae (Text-fig. 14); in male tc setae on VIII finer and shorter (Text-fig. 11); female genital opening narrow and curved (Ethiopian) ***bicolor*** (p. 137)	
7	(5)	Normally 4 (2 tl + 2 tc) setae on terga III and IV, and 2 tc setae on terga V–VII[4] (Text-fig. 15) (Ethiopian) ***senegalensis*** sp. n. (p. 139)	
–		Normally 4 (2 tl + 2 tc) setae on terga III–VII[5] (Text-figs 17, 19)	8
8	(7)	On prothorax 1 + 1 ml posterior setae (Text-fig. 8); male genitalia diagnostic (fig. 15 in Kumar & Tandan, 1968); in female characteristic pigmented antero-lateral spots on terga V–VIII (Text-fig. 17) (Nearctic and Neotropical) ***loculator*** (p. 150)	
–		On prothorax 2 + 2 posterior setae, outer sp or sh, inner ml to lg (Text-figs 2, 3)	9
9	(8)	The 2 sc setae on III almost lg and longer than 2 sh to ml sl setae. In male 5–8 sternal setae on VIII (Text-fig. 28) and genitalia diagnostic (fig. 43 in Clay & Hopkins, 1950). In female anterior margin of tergite IX–XI deeply emarginate and the 2 anterior tergal setae close to its lateral margins (Ethiopian) ***ciconiae*** (p. 152)	
–		The 2 sl setae on III ml to lg and much longer than the 2 usually m or sh and fine sc setae (figs 1, 9, 11 in Kumar & Tandan, 1968). In male normally 2 sternal setae on VIII	10

10 (9) In male 4 (2 sl lg + 2 sc m) sternal setae on V, and the 2 tc setae on VIII reach to anterior tergal setae on IX–XI (figs 1, 5 in Kumar & Tandan, 1968). In female 3–4 (1–2 sl sh or lg + 2 sc m or lg) sternal setae on V[2] (Neotropical) . . . . . ***hopkinsi*** (p. 153)

– In male either no or only 2 m or sh sc setae on V (fig. 9 in Kumar & Tandan, 1968) and the 2 tc setae on VIII fall much or rather short of anterior tergal setae on IX–XI (Text-figs 19, 34–37). In female as in male . . . 11

11 (10) Poorly sclerotized with only traces of pigment; 2 sc setae on II normally m, sp or sh and fine. In male normally 1 + 1 pleural setae on IV and genitalia diagnostic (figs 9, 13 in Kumar & Tandan, 1968) (Neotropical) ***leucosoma*** (p. 152)

– *Either* feebly to moderately sclerotized and fairly to considerably pigmented *or* heavily sclerotized: 2 sc setae on II usually ml to lg. In male 4 or more pleural setae on IV 12

12 (11) Heavily sclerotized, tergal thickening II–XI sharply distinct. In male anterior margin of tergite V incised medially (Text-fig. 19) and mesosome short and diagnostic (Text-fig. 53); in female no spermathecal sclerite[3] (Oriental) . . . . . ***castaneus*** (p. 141)

– Feebly to moderately sclerotized, tergal thickening indistinct but some tergites usually well pigmented laterally. In male genitalia mesosome long and diagnostic (Text-figs 54–57); in female a sclerotized, ring-like calyx to spermatheca (Text-fig. 59) 13

13 (12) Tergum II unpigmented; colour pattern of tergal thickening III–VI or VII in male and III–VIII in female diagnostic (Pl. I, fig. 4; Pl. II, fig. 8). Basal apodeme and lower endomere (Text-fig. 56) under 0·80 mm and 0·175 mm long respectively (Ethiopian). . . . ***keleri*** sp. n. (p. 148)

– Tergum II pigmented laterally; colour pattern of tergal thickening III–VIII not as above. Basal apodeme and lower endomere over 0·90 mm and 0·175 mm long respectively 14

14 (13) Sclerotization moderate; abdominal dorsum as in Pls I, fig. 1 and II, fig. 5; lower endomere over 0·225 mm long (Palaearctic) . . ***maculatus*** (p. 143)

– Sclerotization feeble; abdominal dorsum rather different; lower endomere under 0·225 mm long 15

15 (14) Lower endomere under 0·200 mm long; seta *p* less translucent (Oriental). ***tantali*** (p. 145)

– Lower endomere 0·206 mm long seta *p* quite translucent[6] (Oriental). ***asiaticus*** sp. n. (p. 146)

NOTES TO KEY

1. Variation in the number of segments having the post-spiracular setae is rare, hence their distribution is an exceptionally stable taxonomic character. The recorded absence on segments normally having these setae is due mostly (if not exclusively) to their being broken and the failure to locate even their alveoli as specimens were over-treated with alkali. As opposed to this, only one male of *dissourae*, out of all the specimens from the Ciconiidae, was exceptional in having 1+0 post-spiracular seta on a segment (II) which normally lacks this seta in this species.

2. Whether or not the post-spiracular setae are normally present on tergum III in *hopkinsi* is uncertain. Of the three individuals comprising the series, only in one female tergum III has 1+1 of these setae. In the other female and only male these setae are either absent or not apparent on tergum III. Thus, for covering *hopkinsi* the lower half of the couplet (1) in the key could also be: 'post-spiracular setae present on terga III or IV-VII.'

3. The position in *castaneus* also deserves mention. In only one specimen of each sex, 1+1 post-spiracular setae were seen on tergum III; in the rest either no (five of each sex) or only one (two males, three females) such seta is visible. On IV, 1+1 post-spiracular setae are present in four males and five females; on V-VII, 1+1 setae are present in all specimens excepting on V in two and VI in one female, in which only one seta is visible. It is because most of the seta are broken and even their alveoli are not visible that in five specimens of each sex the post-spiracular setae have not been seen on tergum III (or in some on tergum IV). Hence, their absence on these terga is not accepted as final and this species is also included in the lower half of couplet 1.

4. While in the male of *senegalensis* the normal number of tl setae on II is 2, the two females have more (3–4) tl setae. As such a difference between the two sexes has not been observed in any other species from the Ciconiidae, possibly the females are abnormal. Therefore, 3–4 as the normal number of tl setae on segment II of the female has been accepted with reservation, until confirmed by a larger series. The immediate implication is that the two females are not covered by the relevant portion of the lower half of couplet 3; to include these, the following needs to be added at the end of this half: 'in female rarely 5–6 (3–4 tl + 2 tc) setae on tergum II.'

5. In *ciconiae* 2 tl setae on segments II-VI and VII are present in at least 60 per cent. of the specimens of each sex, and rarely are these setae absent altogether. But on segments V and VI, 2 tl setae are present in 25 per cent. of the females and 50 per cent. of the males. Hence, the relevant portion of the lower half of couplets 3, 5 and 7 does not apply to those high percentage of variants which have either none or only 1 tl seta. For diagnosing *ciconiae*, therefore, through the key a series or males are essential.

6. Females of *tantali* and *asiaticus* are inseparable morphologically.

ACKNOWLEDGEMENTS

We are grateful to the Trustees of the British Museum (Natural History) for the loan of *Ardeicola* from the Entomological Collections of the BMNH, and for the photomicrographs on Plates I and II; and to Dr Theresa Clay for reading the manuscript and making some valuable suggestions.

We are also grateful to Dr M. B. Lal, F.N.I., Vice-Chancellor, University of Lucknow, for his unceasing interest in our work, and to Professor P. D. Gupta for the Departmental facilities. We thank Dr Donald W. Tuff for the loan of a series of *Ardeicola loculator*.

This research has been financed in part by a grant, FG-In-179 (A7-ENT-28), made to B.K.T. by the U.S. Department of Agriculture under P.L. 480. Thanks are expressed to Drs K. C. Emerson, R. I. Sailer, W. H. Anderson and Paul W. Oman, who sponsored the grant, and to the U.S.D.A., A.R.S. authorities in New Delhi and Washington, D.C. P.K. is also thankful to the Government of India for the award of a Research Training Scholarship from 1965–68.

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EXPLANATION OF ABBREVIATIONS

ant	anterior	sh	short
elg	elongated	sl	sternolateral
lg	long	sp	spiniform
m	minute	tc	tergocentral
ml	moderately long	telg	thoracic elongated seta
post	posterior	tl	tergolateral
ps	post-spiracular	tsp	thoracic spiniform seta
sc	sternocentral	ttr	thoracic trichobothrium

For convenience some abdominal setae have been designated as *a*, *b*, *d*, *p* and *v* (Text-figs 20–27, 33–37, 58, 59); the anal setae of the female as inner (i), middle (m) and outer (o) (Text-figs 38–43), the inner being towards the midline, and those of the male as anterior (a), middle (m) and posterior (p) (Text-figs 44–47).